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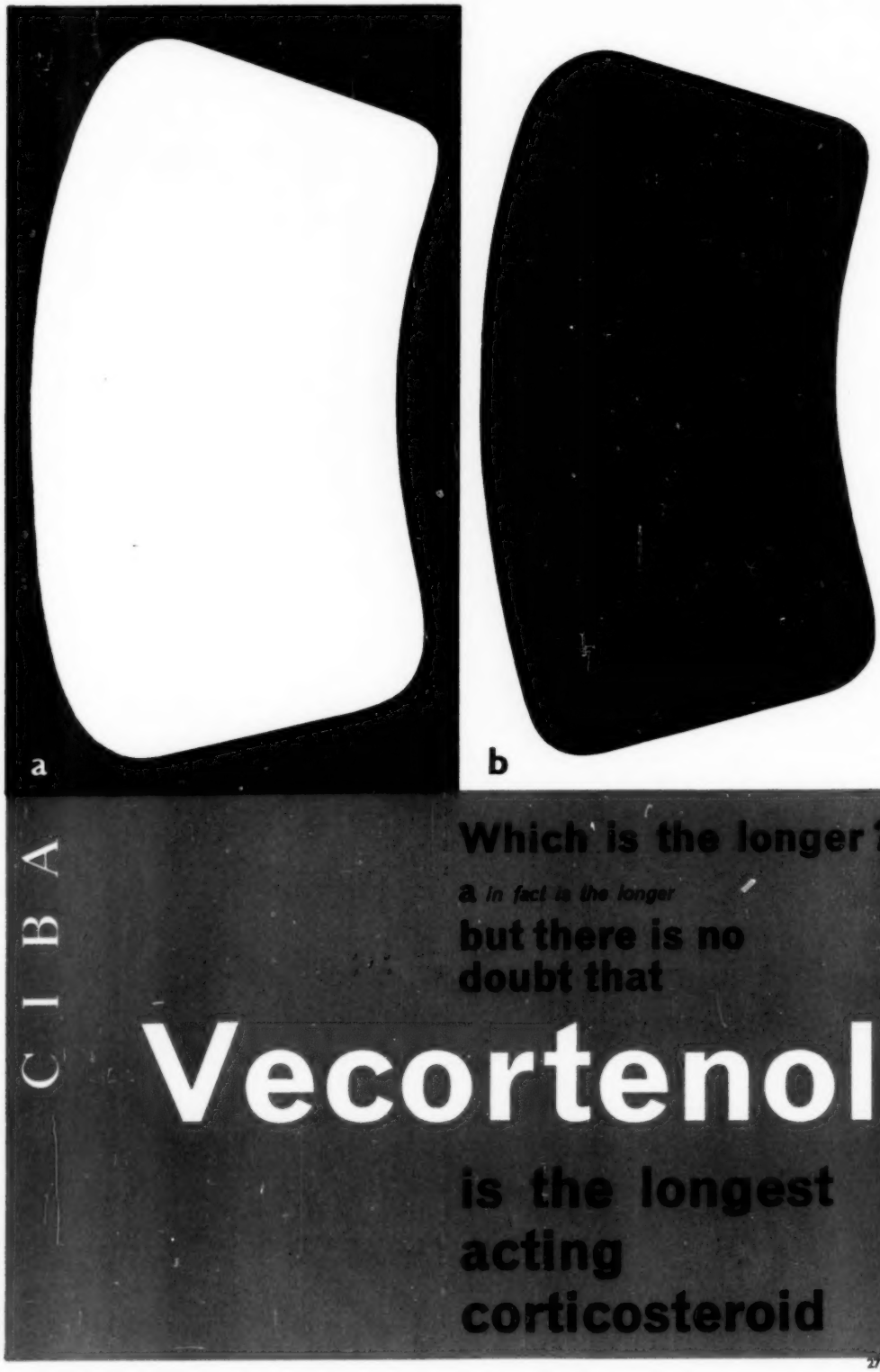
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Enteric Diseases of Calves

ONE of the most interesting sessions at this year's Congress in Glasgow was that devoted to enteric diseases of calves, a subject which is still a problem for every veterinary surgeon in country practice.

The death rate among calves of under 2 months is often disturbingly high, and now that herds tend to rear their own replacements more than in the past, losses of up to 10 per cent. of the calves can seriously disrupt a planned breeding programme.

There has, moreover, been a marked increase in the number of beef cattle, and in this case the loss of the calf usually means the loss of income from that cow for a year.

Withers, in his survey, found that these losses had remained remarkably constant for a good many years in spite of the many antibiotics now available for the treatment of these diseases. The basic pattern of enteric disease of calves has not altered very much, the major cause of illness and mortality still being associated with the white scour syndrome in very young calves generally attributed to infection with *Escherichia coli*. There are still many factors affecting the incidence and severity of this disease which are very imperfectly understood and which call for further research. These relate to such matters as the nutrition of both calf and dam before the birth of the calf, as well as the environment of the dam in late pregnancy. Ever since the notable pioneer work by Lovell and colleagues at the National Institute for Research in Dairying on coliform scours there have been many workers engaged on the bacteriological investigation of this problem, and among these Williams Smith deserves great commendation. These workers have greatly advanced our knowledge of the problem in many respects.

We now have two papers from Glasgow University Veterinary School—that by Professor Inglis dealing principally with the relationship of husbandry to calf scours, and the other by a team of workers giving the results of controlled experiments to evaluate the use of antibiotics in the control of the disease. These have in practice proved a considerable boon in treatment when given in the early stages of the infection, but on many farms there is soon evolved an organism capable of resisting the effects of one or more of the normal antibiotics. It is for this reason that many in practice hesitate to adopt the use of antibiotics in calf feeds as a prophylactic measure lest by so doing they increase the number of bacteria resistant to the available forms of therapy. It would appear, however, that the incidence of salmonella infection has undoubtedly increased, usually in rather older calves and in those herds where the calves are bought in from markets and dealers. These young, highly susceptible animals are often moved through two or three premises under conditions entailing considerable exhaustion, and it is not surprising that some of them easily succumb to infection.

In addition to these recognised forms of scour there is to-day an appreciable amount of nutritional scour associated with the careless and improper use of the many artificial rearing meals now available.

The trend of research has been principally concentrated on the bacteriology of scours and the results of treatment with the antibiotics, so that there has perhaps been a tendency among the farming community to overlook to some extent the importance of husbandry in the basic control of the conditions. In the case of nutritional scour poor housing with excessive range of day and night temperature coupled with careless and often slipshod methods of feeding are clearly implicated, in spite of the excellent instructions usually issued by the makers of artificial calf milks.

Calf rearing does not lend itself to the methods of mass production but calls for someone who is prepared to exercise care and understanding in the task as well as having a genuine interest in the calves themselves.

It must always be remembered that milk is still without doubt the best food for rearing calves and there seems adequate ground for thinking it good practice to maintain milk feeding for at least 2 weeks after birth since by so doing one can reduce the margin of human error which is the principal cause of failure with the artificial calf foods.

The present-day method of rearing calves, under which they are weaned on to dry feeding by the age of 6 weeks, seems to provide a method for eliminating some of the pitfalls of the past.

Congress Papers

SYMPOSIUM ON ENTERIC DISEASES OF CALVES*

(1) The Relationship of Husbandry to Calf Scours: a Review

BY

J. S. S. INGLIS

Department of Animal Husbandry and Veterinary Preventive Medicine, University of Glasgow

SUMMARY.—A review has been made of the research work which would appear to be of special importance in connexion with the relationship of husbandry to calf scours. Particular attention has been paid to infection, nutrition of the dam, nutrition of the calf and environmental temperatures in the consideration of this problem. Reference has also been made to field observations carried out by the author in the South West of Scotland over a period of years and these observations are compared with research findings in the literature reviewed. It would appear from the consideration of the literature on this subject that calf scour is a complicated syndrome associated with a number of contributory factors.

Introduction

PROFESSOR M. G. Fincher (1956) wrote as follows: "Calves may be born at full term from apparently normal cattle and die from acute septicaemia in 12 to 96 hours, many scour profusely for several days or may have milder diarrhoea for a variable period. Several of a group of affected calves may survive, only to terminate in unthriftiness with or without pneumonia." Fincher might well have been describing the disease as we see it in the south-west of Scotland. With regard to aetiology Fincher says, "this defies accurate description, but the condition is assumed to be due to a great variety of known and, no doubt, several undiscovered factors."

A number of observers have recorded that the high incidence of deaths in calves is seasonal, the late winter and early spring months being the bad periods (Jordan, 1933; Lovell & Hill, 1940; Withers, 1952). In the south-west of Scotland, which is an area with a particularly heavy death rate in calves, the position becomes increasingly bad during January, February, March and early April. After the cows have been at grass for a few weeks the incidence decreases greatly. However, we do get a certain amount of calf enteritis in the autumn and sometimes outbreaks occur even during the summer. It is often said that the farther the cows get away from the grass the greater is the calf mortality and the greater is the incidence of scouring. Now I am sure it will be agreed that where a disease is seasonal, factors in addition to the infective agent must be important. I propose discussing this subject under the headings Infection, Nutrition of Dam, Nutrition of Calf, and Environmental Temperatures. I have omitted the special problems associated with parasitic infestation on account of the time limit.

* Papers presented to the Annual Congress of the British Veterinary Association in Glasgow on Friday, September 2nd, 1960.

Infection

Quite a number of workers, including Jensen (1892-3) have emphasised the widespread involvement of certain strains of *Escherichia coli* in calf enteritis and septicaemia; still in 1959 we find Osborne *et al.* writing, "while the principal genus of bacteria isolated was *Escherichia*, it remains to be demonstrated that this genus represents a primary cause of calf scours." McEwan (1950) had found that when a large number of *E. coli* isolated from dead calves were fed to normal calves, although the strain fed could be recovered from the lymph glands draining the intestine, the calves remained healthy. However, Glantz *et al.* (1959) reported that when colostrum-deprived calves were fed certain strains of *E. coli* fatal scours developed and that one strain caused scours even in calves which had suckled their dams. *Salmonella* species have been involved in numerous outbreaks as have also quite a number of other bacterial agents. Some workers, including Baker (1943), have implicated viruses. Work on the aetiology of that type of scour known as colibacillosis was carried out at Shinfield, Reading, and at the Royal Veterinary College: a summary of this work was included in a review by Lovell (1955). Roy *et al.* (1955) following observations made under experimental conditions suggested that build up of infection through a period of use of a calf pen may be partially responsible for the known increase in scouring and mortality in calves in the late winter. Wood (1955), however, suggested that the observed "build up of infection" is related to the presence of special serological types of *E. coli* introduced into the calf house and that by a process of natural selection the most virulent strains become predominant; this suggestion was also made following experimental observations.

In view of the foregoing findings, under experimental conditions, an obviously important aspect of management under field conditions is the cutting down of infection as far as possible by constructing housing so that it can be properly cleaned and disinfected, and by carrying out such regular cleansing and disinfection, penning calves individually in the early stages of life and having solid divisions between pens, by taking proper hygienic measures with feeding utensils, and by adopting appropriate precautions to prevent infection being introduced from markets, etc. Nevertheless, in investigating outbreaks of calf disease I have on many occasions had the pens disinfected and even had new-born calves kept in pens not previously used for this purpose, or in houses which had not accommodated calves for a very long time; I have also had the cows calve in such places,

but all without avail—the scouring and deaths continued pretty much as before.

Nutrition of Dam

A number of workers have emphasised the importance of nutrition as a factor in calf disease. There are 2 aspects of nutrition to be considered; nutrition of the dam and nutrition of the calf.

Williams (1940) stated that in his experience the early health of the calf was influenced by the nutrition of the embryo. Scour was observed in calves at birth, and a foetal scour was described. He also suggested that "many calves born without diarrhoea must be upon the brink of that phenomenon." Sheehy (1948) stated that, "cows suffering from a chronic deficiency of phosphate in their diet give birth to weak calves, similarly the calves from cows whose diet provides inadequate iodine, may be born dead or goitrous, and cows whose food intake during pregnancy is seriously deficient in vitamin A or carotene produce weak calves which are highly susceptible to scour and pneumonia, and among which casualties are numerous." Dr. Alan Fraser (1953) says, "from what has been proved in sheep, it is altogether probable that the nutrition of the cow, while pregnant, will influence the development of the unborn calf, but that effect will be confined, in the main, to the last 3 months or so of the cow's pregnancy." Mackintosh (1953) said, "the size and vigour of the calf is also influenced by the feeding of the dam before calving. The in-calf cow or heifer should have a diet in which good pasture, green fodder, silage or hay are abundant, so that ample supplies of protein, mineral matter and vitamins are available. When the cow's diet is seriously deficient the calf will be undernourished and weakly."

Withers (1953) also concluded that the nutrition of the dam during pregnancy and the standards of housing and hygiene had some relationship to calf mortality, but that these are of secondary importance to the effects of climate, the methods of feeding colostrum and the personal factor. He emphasised that the intake of green food appeared to exercise some influence on the viability of the calf and that several herds with bad calf mortality records were deficient in this respect. He suggested that probably the combined effects of adverse weather conditions and a low vitamin A content of the colostrum are responsible for much of the mortality in the early months of the year. Withers also noted that calf mortality in dairy herds was much greater than in beef herds where more natural management is the rule.

Payne (1949) reported that nutritional scours in calves were less frequent where cows were fed large amounts of grass silage or artificially dried grass than where a high proportion of imported concentrates was fed.

Stewart and McCallum (1938) obtained statistically significant results showing that calves born of mothers whose colostrum was low in vitamin A were more liable to infections such as white scour, navel-ill and joint-ill than calves from dams whose colostrum had relatively higher vitamin A content. The same authors found that the vitamin A content of the liver of cows slaughtered in S.W. Scotland was liable to fall steeply from November to May, although they found a good deal of variation from year to year. The minimum values occurred in April and May within a short time of animals being transferred from stalls to pasture, and they clearly demonstrated that there was a sharp fall during February and March. The April figures for vitamin A were only about a quarter of those for November. Spielman *et al.* (1946) found also that the *pre-partum* diet of the dam affected the vitamin A of the calf at birth. Hansen *et al.* (1946) said it appeared from their experiments that some factor or factors are present in summer skimmed milk or in intrauterine life or both which favourably influence survival rates of calves dropped from June 1 to January 1. Spielman *et al.* (1949) found that the incidence of scours was lower in calves from dams fed vitamin A (1 million I.U. per day) for 30 days before parturition. They claimed that their data furnished additional evidence of the importance of the *pre-partum* ration in the subsequent performance of the new-born calf. Squibb *et al.* (1948) made an interesting observation in this connexion when they showed that certain legume seeds, *i.e.* raw soya beans, soya bean oil, caused the blood plasma carotene to be lower than in cows fed a control ration containing no soya bean products. Differences levelled off after 6 to 8 weeks. The ration also caused small variations with no particular trend in the vitamin A.

I feel the above findings with regard to the possibility that vitamin A deficiency in the *pre-partum* diet plays a part in calf enteritis fit well in with the field observations within my own experience. In a great many cases the diets encountered on farms experiencing a high death rate in calves have been apparently deficient in vitamin A potential on account of poor quality of hay or silage or straw making up the bulky part of the diet, and we have encountered such conditions both in dairy herds and beef herds. On many occasions farmers have also pointed out that scour and mortality in calves commenced after certain changes in the constitution of the concentrate ration, or even following the change on to a winter ration in October.

In many of these cases feeding a more natural type of diet adequate in green food of good quality hay has been followed by an improvement in calf health. In my opinion there is a good case for further study of the effect of prenatal diet of the dam on enteritis and mortality in calves, particularly of the effect of shortage of vitamin A and the effects of certain high protein foods. We must also bear in mind in this connexion that certain high protein foods such as white fish meal have been found infected with *Salmonella* organisms from time to time. I personally feel that the case is fairly strong with regard to various aspects of the nutrition of the dam being important in relation to calf enteritis.

Nutrition of the Calf

Many research workers have studied the relationship of the nutrition of the calf to enteritis. Smith and Little (1922) showed that calves which did not receive their colostrum either died or grew poorly

on account of scouring. Since then numerous experiments have confirmed the protective effect of colostrum and also extended the knowledge of the nature of the protective mechanism. It is now generally accepted that the calf can absorb the very important immune lactoglobulins only during the first 24 or 36 hours after birth. The importance of feeding colostrum during the first few days of life is well recognised in this part of the country, and in investigations conducted on a large number of farms experiencing a heavy death rate in calves I have not yet encountered a case which I could definitely attribute to colostrum not being fed. I have come to the conclusion that omitting the feeding of colostrum is not a common cause of enteritis in this district—the calves scour and die in spite of receiving colostrum, and in some cases even when they are getting the colostrum by suckling. Sometimes the dam is *pre-partum* milked when at parturition the udder secretion is no longer colostrum. A number of workers have compared this secretion with colostrum in relation to the development of calf enteritis and certain workers including Turner (1931) and Keyes *et al.* (1944) found that the calves of *pre-partum* milked cows scoured and died more readily than those from dams not so treated, Aschaffenburg *et al.* (1951) found that calves fed with such secretion gave a poorer performance. However, Hill *et al.* (1951) experienced no difficulty in rearing calves from *pre-partum* milked cows where the importance of hygiene was observed.

Roy (1959) stated that "without doubt the main predisposing cause of scouring is the quality and quantity of the diet given after the colostrum-feeding period." Pounden and Hibbs (1947) stated that overfeeding with milk can initiate scour and that a serious predisposing cause of scour is a too high protein content of the diet. Other workers have also arrived at this conclusion—that over-feeding of the calf was dangerous, from the point of view of enteritis and scour. In the field one has encountered scouring in calves in beef herds where the cows have been fed on concentrate ration somewhat richer than usual and would consequently milk particularly well. In spite of the above findings I am sure all veterinary surgeons have encountered outbreaks of scour, which could not be prevented simply by controlling the amount of food intake. Nevertheless I feel it is of real importance to avoid over-feeding in the early stages of life. Certain workers have claimed that too little milk will lead to scouring, especially in older calves, *e.g.* Ingham *et al.* (1930). This is a type of enteritis with which many veterinary surgeons are familiar, where calves are fed very sparingly on milk and given unsuitable alternative foodstuffs.

The feeding of vitamin supplements to the young calf has been the subject of numerous experiments. Stewart and McCallum (1938) suggested that calves fed colostrum with a high vitamin A potential were better able to resist scours than those fed colostrum which was poor in vitamin A. Between 1941 and 1946 workers at Wisconsin, in the earlier stages of their experiments, concluded that where calves were given no colostrum, supplements of vitamin A plus nicotinic acid gave a fairly high survival rate, and even vitamin C gave some benefit. However, they subsequently found that when a vitamin A supplement was adequate (25,000 I.U. per calf per day) the effect of a niacin supplement was negligible. Miles *et al.* (1948) also claimed benefits from comprehensive vitamin supplement. Hibbs and Kraus (1947) concluded that vitamin supplements containing vitamin A, niacin and vitamin C were of doubful value in preventing scour where colostrum was fed, and Nevens and Kendall (1947) found vitamins A, D, C and nicotinic acid all of doubtful value where colostrum had been fed. Blakemore *et al.* (1948) had also found that vitamin A was not effective in preventing scours in calves which had been denied colostrum. Esh *et al.* (1948) found that where calves did not get colostrum a supplement of vitamin A and lecithin was beneficial, while a supplement of vitamin A alone was not satisfactory. Aschaffenburg *et al.* (1953) working at Reading failed to confirm these American findings and found no benefit from feeding vitamin A and lecithin or vitamin A alone where colostrum had been denied.

The above findings, and many others, leave one in doubt about practical benefits of vitamin supplements fed to the young calf in preventing enteritis, especially where colostrum has been fed, although they do suggest that in some instances vitamin deficiencies may be of importance. It is certain that a vitamin supplement is not effective in many instances in preventing enteritis.

Shanks (1950) encountered diarrhoea in calves coincident with having the cows producing milk for them on luscious pastures. He considered there was a possibility of substances in the rich pasture passing through the mother's milk to the calves. He succeeded in reproducing this condition experimentally on a small scale with controls which did not scour. In the field we do encounter from time to time scours in calves in the summer when cows are on luscious grazing, but this is relatively infrequent in my experience.

Sheehy (1948) found advantages in the treatment of calf diarrhoea in diluting milk with water previously boiled, and he also claimed advantages in feeding water alone for one day and then milk and water in equal parts for the next 2 days. He also found dilution of milk with 25 per cent. water was a preventive against calf enteritis, but that odd animals required to have the milk more extensively diluted. Another of his findings was that calves could tolerate the undiluted milk from freshly calved cows better than that from animals in later lactation. Lovell and Bradford Hill (1940) as a result of field observations suggested "that the mortality in these herds was not influenced by the three methods of feeding (suckling, bucket fed with undiluted milk, and bucket fed with diluted milk)." In the field to-day, many people will agree that there are advantages in diluting milk as recommended by Sheehy, but on other farms experiencing scours and septicaemia resorting to Sheehy's recommendations is quite without avail. One might add that Sheehy encountered outbreaks of enteritis where his methods of prevention were ineffective.

Sheehy also found some advantage in feeding 3

times daily, instead of the usual twice, but this did not by any means eliminate scouring; other authorities have claimed slight advantages for this method. Of course we all know that many millions of calves have been reared successfully on twice daily feeding; however, there may be advantages in feeding the calf which is in a marginal state of health 3 times daily—it would appear to be a sensible thing to do. To go to the other extreme, Blaxter *et al.* (1951) found that deliberate overloading of the abomasum by suddenly giving the whole daily allowance of food in one feed induced scours.

There is a consensus of opinion that suckled calves do better than bucket-fed calves, but everyone is aware that suckling is frequently impracticable. However, one might again refer to the work of Lovell and Bradford Hill (1940) when they found that mortality was not influenced by the three methods of feeding as set out above, but their work suggested "that there is an advantage in allowing the calf to take the colostrum naturally from its mother." One must bear in mind that in this series of observations there were few herds in the suckled group. I have been informed by my veterinary colleagues that the adoption of a suckling regime for the first few days of life has on occasion improved the calf enteritis position, but in many herds where I have investigated an enteritis problem scouring and deaths continued in spite of adopting a suckling method of rearing. Where the dam or foster mother is producing too much milk suckling may, on occasion, lead to a calf receiving too much milk, and it is widely believed that setting a very young calf on to a cow in late lactation has certain dangers.

Intermittent attempts to improve on bucket feeding have been made since last century mainly by the use of some type of vessel with a nipple which the calf could suck. Some workers have claimed small advantages for nipple pails, others have discarded them on account of pail feeding being more satisfactory. Even in 1960, I find a report from Yugoslavia claiming a slight advantage for the nipple pail, and one from South America where they found no advantage. Certainly the nipple adds to the expense of the equipment and needs extra care in cleaning and disinfection.

The prophylactic effect of including antibiotic supplements in the calf's food has been the subject of many studies. A number of workers have reported beneficial results both on the incidence and severity of scours of feeding a chlortetracycline* supplement. The publications of Roy *et al.* (1955) and Taylor and Gordon (1954) illustrated particularly well the prophylactic value of this antibiotic under conditions favouring the development of calf scours. Others have reported that under the conditions of their experiments chlortetracycline had no effect on the incidence of scours, paricularly under conditions of "low infection." These experimental findings fit in well with field observations, where I believe the finding is that chlortetracycline is frequently effective as a preventative of calf enteritis and sometimes it is not. Although oxytetracycline† has not been so extensively studied a number of workers have observed that this substance has also a prophylactic effect on the incidence of scours—indeed it has been suggested its effects are similar to those of chlortetracycline. I do not propose discussing further the effects of antibiotic supplementation of the diet of young calves as my colleagues in this symposium will be dealing with this aspect.

One of the marked changes we have witnessed in calf nutrition in recent years has been the wide adoption of the so-called "early weaning" systems where calves are put wholly on to dry food at an early age, say 5 weeks. This development has been closely linked with the preparation of compound pencils suitably made up and balanced for calves at this stage. In my experience this system has been successful on the vast majority of farms. One has occasionally encountered scouring and this could be accounted for in most cases by the farmers not accustoming the calves to dry food and water right from the colostral phase. I have also encountered enteritis where the farmer put his calves of about 2 months old on to unsuitable foods instead of the specially prepared rearing compounds.

Environmental Temperatures

As previously stated, Withers (1953) concluded that the effect of adverse climatic conditions including wide temperature variations and absence of sunshine was among the factors contributing to much of the calf mortality in the early months of the year. Many veterinary surgeons in this country have remarked to me that they also considered cold conditions in the calf pens of importance in relation to calf mortality. Certain American veterinarians have emphasised to me the adverse effects of draughts blowing on the calves. Yet we have a number of reports of calves being kept in open conditions without any untoward effect. Roy *et al.* (1955) successfully reared dairy shorthorn calves out of doors from a few hours old during the months of February, March and April, and came to the conclusion that weather had little effect on scouring; the calves were sheltered from the prevailing wind by a cluster of bales of straw. Erb *et al.* (1951) reared young calves in open sheds where the temperature dropped to a minimum of −20°F. and experienced a death rate of 2 per cent. which was much lower than he was encountering in conventional barns. There was some frostbite on the ears of the calves at the extreme low temperatures. Murley *et al.* (1958) found no advantage in conventional barns over open sheds for dairy calves from 3 days old—the temperatures in the open sheds ranged from 13° to 100° F.; they concluded that the lower temperature did not affect the health of the calves. Other workers in America report similar results but emphasise the importance of shelter from draughts and the provision of adequate litter. The German workers Hofmann and Schwark (1958) reared calves under conditions where the minimum temperatures were −19°C. and −5°C. and health was normal under both set of conditions. We know that calves in our commercial beef herds in this country are often borne in adverse weather on

(*Concluded at foot of page* 1178)

* Aureomycin.
† Terramycin.

(2) The Ecology of the Intestinal Bacteria of the Calf with Particular Regard to *Escherichia coli*

BY

H. WILLIAMS SMITH

The Animal Health Trust,
Farm Livestock Research Centre, Stock, Essex

SUMMARY.—The available evidence indicates that the proliferation of Escherichia coli *in the upper regions of the intestinal tract is an important factor in the aetiology of natural cases of calf scour. However, bacterial counts of the faeces do not reveal any quantitative or qualitative difference between healthy and scouring calves; the* E. coli *are usually outnumbered by other bacteria.*

Bacteriophage typing has stressed the complexity of studies on the ecology of E. coli *in the intestinal tract of calves. The complexities include the multiplicity of types of* E. coli *in the faeces, the similarity between types found in healthy and scouring calves and changes of dominant type during the scour period.*

Antibiotics have a profound effect on the emergence of resistant strains of E. coli *in the faeces of treated and in-contact calves. The widespread use*

The Relationship of Husbandry to Calf Scours.—*Concluded.*

the hills and obtain only the shelter which the dam can find or provide. Again, the interpretation of all these findings is difficult, and I feel that while a healthy calf can withstand a wide variety of temperature conditions, it may be a very different story in the case of a calf in a marginal state of health. However, in my experience the provision of artificial heat has failed to stop the death rate in certain herds experiencing calf enteritis; yet we find ourselves at times feeling we must put a heating lamp over a very valuable calf when the problems of calf enteritis and septicaemia are bothering us. I feel it is sound procedure to recommend a well-insulated calf house, not too high, well ventilated but free from draughts.

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of these agents is now being reflected in the increased incidence of resistant strains in the general calf population.

IT is not easy to obtain convincing evidence incriminating bacteria which are normal inhabitants of the alimentary tract as also being able, under certain conditions, to produce disease in that tract. This is particularly so in the case of a clinical syndrome as complex as that of calf scour. It is all the more surprising, then, that from the very beginning of its bacteriological history, as long ago as the end of the 19th century, a substantial degree of unanimity has existed in considering that calf scours is caused either by *Escherichia coli* or that there is an important association between this organism and the disease process. Why, precisely, the earlier investigators held this view is rather obscure. One imagines that the prominence they gave to *E. coli* might have been influenced to some extent by the fact that this organism could be cultivated and identified so readily by means of the simple bacteriological media then available; many other bacterial types that inhabit the alimentary tract in large numbers have more complex growth requirements. Later work, notably that of Theobald Smith and his colleagues, brought forward more important evidence incriminating *E. coli*, work which has culminated in the convincing studies of a team of workers from the National Institute for Research in Dairying and the Royal Veterinary College, London. These latter observations have been summarised by Lovell (1955) although two papers have been published since (Wood, 1955; Ingram, *et al.*, 1956).

Much of the work that has led to the better understanding of calf scours has been carried out on colostrum-deprived calves in which the disease usually terminated in an *E. coli* bacteraemia, a fact which facilitates investigation. Under natural conditions, of course, nearly all calves receive colostrum, and in such calves scours only infrequently terminate in bacteraemia. The available evidence indicates that in these calves the *E. coli* produce their harmful effects by proliferating in the small intestine, a region of the alimentary tract in which they are present in only small numbers in healthy calves. The evidence for this, in the main, appears to be based on two observations which, in my opinion, are suggestive but by no means conclusive. The first was by Carpenter and Woods (1924) who found, as a result of culturing on cooked blood agar, much larger amounts of "colon bacilli" in the abomasal, duodenal and jejunal contents of scouring calves than of healthy calves. No actual counts were carried out and no other media or conditions of incubation employed. The second was by Smith and Orcutt (1925) who came to somewhat similar conclusions, pointing out that the more severe the clinical condition the further was the extent of the *E. coli* invasion up the intestinal tract from the lower regions in which they normally resided in the healthy calf. The exact significance of this paper is difficult to interpret owing to a lack of technical information and, consequently, it is not possible to gauge the comprehensiveness of the investigation. There appears, therefore, to be an obvious need for further study on this important aspect of calf scours with particular reference to the bacterial flora as a whole and not merely to its *E. coli* content. A full appreciation of the results of such a study would require an understanding of the dynamics involved in the bacterial colonisation of the initially sterile gut of the new-born calf and of the subsequent development of the bacterial flora in both the healthy and the diseased calf. Most of the studies of this nature have been carried out on babies. Van Pelt, Johnson and Plastridge (1953), however, have examined the bacterial flora of the faeces of calves daily for the first 19 days of life, their studies being confined to the coliform and the total aerobic count. Recently, we (Smith & Crabb, 1960) have extended this work using cultural methods which permit counting of a much greater variety of bacteria. Working initially with healthy calves, we were impressed by the relatively constant manner in which the faecal bacteria flora developed from birth, the form of development varying surprisingly little from calf to calf irrespective of breed, sex, method of management and environment. For example, little difference was noted between suckling Ayrshires and bucket-fed Jerseys kept under different conditions on premises 10 miles apart. The kinds of bacteria that were most prevalent in the faeces were *E. coli*, *Clostridium welchii*, streptococci, lactobacilli and bacteroides (fusiform-like organisms). A diagrammatical expression of the typical manner in which these bacteria develop in the faeces of the new-born calf is illustrated in Fig. 1, being based on observations made on 15 calves, whose faecal bacteria were counted daily for the first 14 days of life, the period during which calf scours usually develops. *E. coli*, *Cl. welchii* and streptococci were the first bacteria to appear in the faeces, often being present in large numbers a day or so after birth. Within a few days, bacteroides and lactobacilli had colonised the faeces in large numbers and outnumbered the other bacteria It was not unusual for the bacteroides, in particular, to be present in numbers one hundred times greater than the *E. coli*. The *Cl. welchii* content of the faeces declined rapidly and usually these organisms were present in small numbers only after the first 7 to 14 days. After 14 days the *E. coli* count usually decreased slowly and at 4 weeks might be present in numbers of one million per gramme of faeces compared with a possible 10.000 million per gramme in the first week of life. By contrast, the bacteroides, lactobacilli and, to a lesser extent, the streptococcal counts remained high.

Bacterial counts have also been carried out on the faeces of scouring calves before, during and after the scour period (Smith & Crabb, unpublished studies) and to date we have not been able to demonstrate any significantly constant difference between the faecal flora of scouring calves and healthy calves. In fact, Figure 1 might be employed equally well to demonstrate the development of the faecal bacterial flora of a calf that scoured during the period of study as to trace the development in a calf that remained healthy throughout the period. Moreover, we were unable to demonstrate any con-

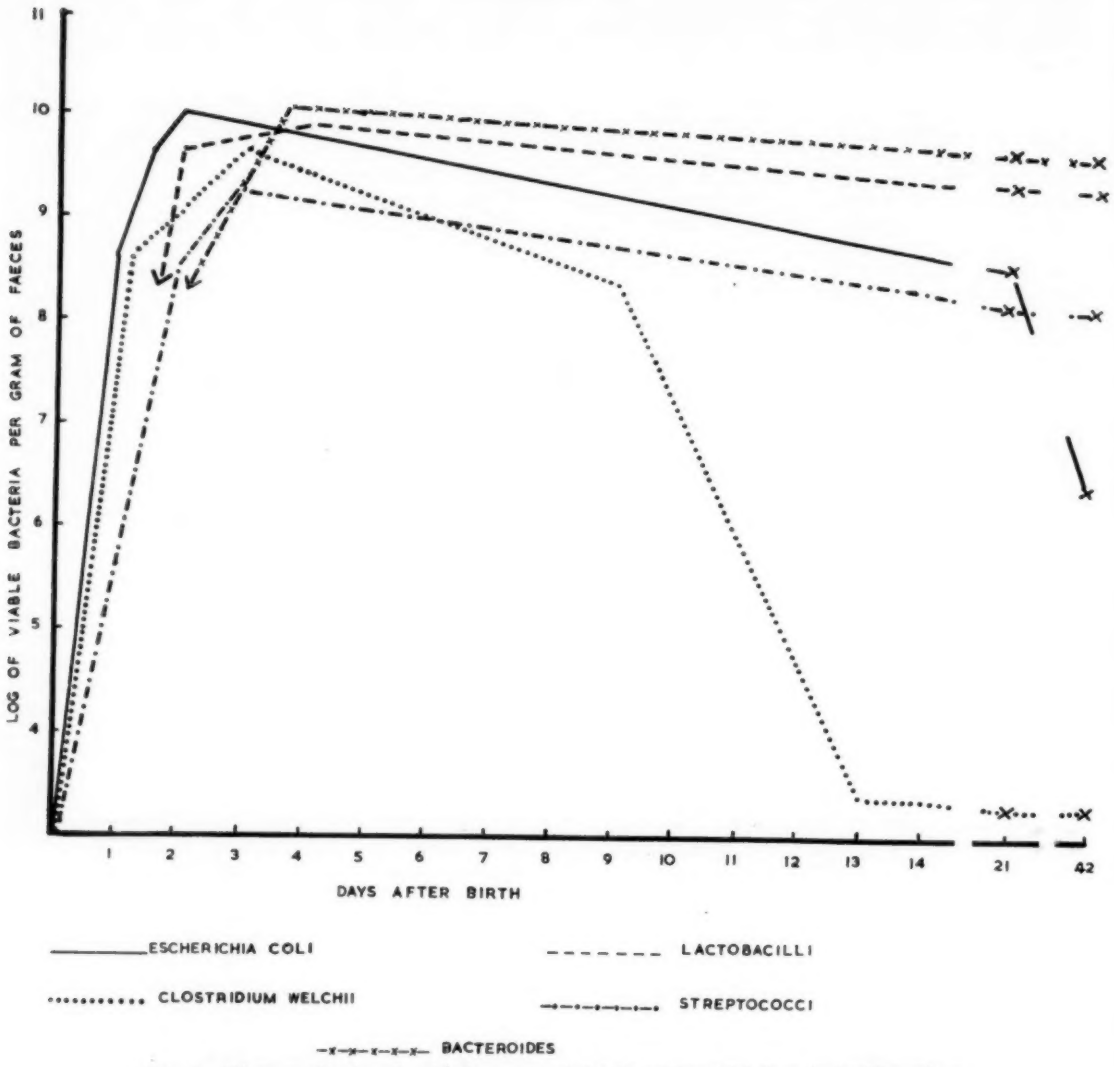

FIG. 1.—Diagram showing the development of the faecal bacterial flora in healthy calves.

stant change occurring in the bacterial flora of the faeces that coincided with the onset of scours. The *E. coli* count, in fact, sometimes decreased at this time, an observation that was also made by Van Pelt *et al.* (1953).

Epidemiological studies on *E. coli* in relation to calf scours have been carried out by several workers but no such studies have been carried out with other intestinal bacteria. The N.I.R.D.-R.V.C. team used serological methods of classifying the *E. coli* in their epidemiological studies (see Lovell, 1955; Wood, 1955). They examined the serological types of *E. coli* isolated from 153 calves that died from scours in a calf house during the 1950-51, 1951-52, 1952-53 seasons, the calves having been brought there from neighbouring farms; many of them had received either no colostrum or only certain fractions of it. The death of each calf was usually associated with one type of *E. coli* that was isolated either from all the tissues or from the intestinal contents and mesenteric lymph nodes only. However, at least 16 different serological types were involved during the whole experimental period, one type being dominant as a cause of death for a time, this type then being supplanted by others, and so on, as the season progressed. Many of these types were also found, frequently in large numbers, in the faeces of healthy calves in the pens.

Cultures of *E. coli* can also be classified into types according to their susceptibility to different bacteriophages and we have used this method in studying the ecology of *E. coli* in a self-contained herd, herd

A, in which scour was a problem and to a lesser extent in 27 other herds (Smith & Crabb, 1956). Calves in herd A all received colostrum and if they scoured their milk intake was reduced in the hope of producing a long scour period of moderate severity rather than a short severe one terminating in death; no other disturbance was made to the normal routine.

The complexity of the study was apparent early in the investigation when 150 colonies of *E. coli* were examined from culture plates prepared from each of 10 faecal samples obtained from 10 healthy calves. From only one of the 10 samples were all 150 colonies of the same bacteriophage type; in the others the number of types found varied from 2 to 8. When it is appreciated that calf faeces may contain 1,000 million or more *E. coli* per gramme, it is apparent that bacteriophage methods of classification (or serological methods for that matter) will only yield information on the *predominant* types of *E. coli*. Many more types may be present in quite considerable numbers, their presence being masked by the overwhelming numbers of the dominant type.

Despite this obvious limitation we were able to throw some light on the ecology of *E. coli*. As many as 70 different types were found in the faeces of the healthy calves in herd A, most of them occurring infrequently. Thirty-two different types were discovered in the faeces of the scouring calves; only one type (one culture only) was found in the scouring calves that was not found in the healthy calves. Many of the types also occurred in the faeces of the cows although 2 types commonly found in the scouring calves were found only rarely in the cows. The mother did not appear to be a frequent source from which a calf acquired its *E. coli;* the calf pens were a more probable source. The examination of *E. coli* cultures isolated from cows and healthy calves at daily and weekly intervals indicated that some types of *E. coli* remained dominant for a week or so in the faeces and were then succeeded in dominance by other types. In some animals, frequent and sudden changes were apparent; in others, one type might remain dominant for a considerable period of time.

The bacteriophage-typing of *E. coli* cultures isolated daily from the faeces of 8 calves before, during and after the scour period were of particular interest. The results for 4 of them are shown in Table I.

The marked similarity in the distribution of phage types in the faeces before, during and after the scour period, the multiplicity of types and the change of dominant type during the scour period (well demonstrated in calf 4) considered together with the close similarity, quantitatively and qualitatively, between the *E. coli* population of healthy and scouring calves made one wonder what part *E. coli* was playing in the disease process. Rather similar results were obtained in many of the other herds studied. In a few herds, however, there was evidence of one particular type being associated with scours. In one self-contained herd, reported more fully elsewhere (Smith, 1958). the dominant *E. coli* in the faeces of all the calves that developed scours during an observation period of one year all belonged to one bacteriophage type, type 2. This type was also found in the faeces of some of the healthy calves but never

TABLE I
PHAGE TYPES OF *E. coli* PRESENT IN THE FAECES OF SCOURING CALVES

Calf No.	Phage types* present in 10 colonies isolated on the following days after birth :											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3(10)	3(8) 2(2)	2(9) 60(1) +++	2(10) +++	2(9) 3(1) +++	2(10) +	2(10)	2(9) 3(1)	2(10)	2(10)	2(1) 38(9)	2(1) 38(9)
2	65(5) 71(4) 26(1)	65(1) 3(2) 38(6) 102(1)	3(3) 38(2) 64(3) UT(2)	3(7) 38(2) 64(1)	3(3) 58(7) +	3(3) 58(7) 10(1) +++	3(1) 38(6) 65(3) ++++	65(10) ++++	65(10) ++	65(10) +	65(3) 3(3) 77(3) 31(1) +	65(1) 77(6) 38(2) 2(1) —
3	3(5) 101(1) 112(3) 128(1)	112(1) 128(2) 2(6) 143(1)	11(4) 31(6)	11(8) 31(2)	11(8) 31(2)	128(10)	128(9) 88(1) +	128(10) ++++	128(10) ++++	128(10) ++++	40(9) 32(1) ++++	— Died
4	144(10)	144(4) 2(1) 88(3) 80(2)	2(4) 88(1) 60(5)	2(4) 96(4)	96(8) 60(2) ++	96(5) 2(3) 60(2) +++	96(6) 2(2) 60(1) 3(1) +++	2(1) 3(9) +++	2(5) 3(4) 96(1) ++++	2(4) 3(3) 60(3) +++	2(4) 3(4) 60(1) 131(1) +++	2(7) 60(1) 80(1) 43(1) ++
Days	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*			
4	2(10)	2(2) 80(4) 3(3) 96(1)	2(4) 3(3) 71(3)	71(9) 80(1)	71 (10)	71(9) 80(1)	71(2) 80(8)	80(10)	80(10)			
	++	++	+	+	++	+	+	++	++			

* The number of colonies belonging to each phage type is given in parentheses. The degree of severity of scouring is indicated by the number of + signs.

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in the faeces of the cows of this herd. Neither were antibodies to type 2 found in the sera of these cows although antibodies were present against many other types found in the cows and in the calves, types that had never been associated with cases of scour on this farm. Leaving the calf pens empty for 6 months resulted in the elimination of type 2 *E. coli*, a process that was accompanied by a marked decrease in the incidence of scours.

No consideration of the ecology of the intestinal bacteria of farm animals can be complete nowadays without some appreciation of the impact that chemotherapy may have upon it. Calves are no exception although, once again, most of the available information relates to *E. coli* only. The profound effect that even a single dose of a chemotherapeutic agent may have on the *E. coli* population of the intestinal tract of the calf is illustrated in Fig. 2 (Smith & Crabb, 1960a), 0.5 g. of streptomycin by mouth reducing the concentration of *E. coli* per gramme of faeces from 100,000,000 to 10, a depressant effect being observed for as long as 5 days after administration of the drug. The effect of giving a dose 4 times greater by injection was much less pronounced, a point of some importance when the chemotherapy of calf scours is considered.

The efficiency of chemotherapeutic agents in eliminating sensitive strains of *E. coli* is matched by the extreme speed at which resistant strains may replace them during chemotherapy. Some results of studying the dynamics of this process are shown in Table II (Smith & Crabb, 1960), changes from a predominantly sensitive to a predominantly resistant *E. coli* faecal flora often taking place within 24 to 48 hours of administering a chemotherapeutic agent. The more general effect of these changes is shown in Table III (Smith, 1958) in which calves are classified according to their degree of exposure to antibiotics and the effect on their *E. coli* faecal flora compared. The majority of the 537 calves examined were under

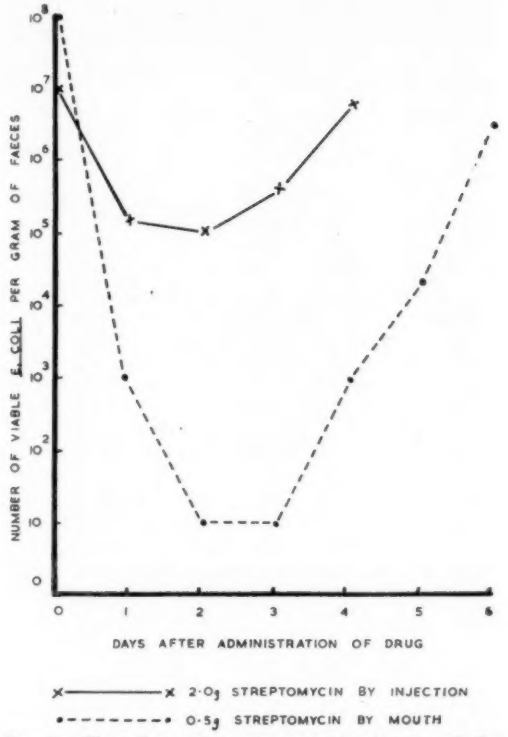
NUMBER OF VIABLE E. COLI PER GRAM OF FAECES
DAYS AFTER ADMINISTRATION OF DRUG
2·0g STREPTOMYCIN BY INJECTION
0·5g STREPTOMYCIN BY MOUTH

FIG. 2.—The effect of streptomycin in the *E. coli* faecal count.

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2 weeks of age. Those in group B originated from 5 farms where it was the policy to give all calves 32 mg. chlortetracycline hydrochloride twice daily

(*Concluded on page opposite*)

TABLE II
EFFECT OF CHEMOTHERAPY ON THE EMERGENCE OF DRUG-RESISTANT STRAINS OF *E. coli* IN CALVES

Drug and dose employed by mouth	Number of resistant *E. coli* per gramme of faeces	
	Before administration	After administration
One dose 0·5 g. streptomycin	1,000	250,000,000
Two doses 0·5 g. oxytetracycline 12 hours apart	10	500,000,000
Four doses of 1·0 g. chloramphenicol 12 hours apart	10	10,000,000,000

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TABLE III
THE PRESENCE OF DRUG-RESISTANT *E. coli* IN THE FAECES OF CALVES OF DIFFERENT CATEGORIES

Category of calves	Number examined	Per cent. of calves whose faeces contained *E. coli* resistant to :			
		Streptomycin	Tetracyclines	Chloramphenicol	Sulphadimidine
A. From herds never given drugs	110	0	6	0	4
B. Fed tetracyclines	75	5	84	0	21
C. Scouring, not responding to drugs	82	79	54	7	73
D. Untreated, from herds where drugs had been used previously	80	41	48	9	61
E. Market calves	190	10	12	1	26

(3) Infection by *Escherichia coli* and Salmonella

BY

P. L. INGRAM and R. LOVELL
Royal Veterinary College, London

Introduction

ESCHERICHIA COLI is still regarded by many workers as a non-pathogenic organism, whereas salmonella are considered as pathogenic for man, animals or both. Pathogenicity is an attribute of a species, genus or group of bacteria, and we are frequently unable to determine the mechanism whereby infection is followed by disturbances leading to disease and possibly the death of the host. The lipopolysaccharide "endotoxins" of *E. coli* and salmonella have the same order of toxicity for mice and there are no apparent differences between the "endotoxins" of strains of *E. coli* recovered from scouring calves and those from other bovine sources. The virulence of a special strain is probably an attribute of the living organism and emphasis in outlook is shifting from toxicity to the relationships of enzymes and their substrates. For example, when hyaluronic acid is present in a tissue then the production of hyaluronidase by an organism is assumed to affect its virulence. A mucinase present in filtrates of *Vibrio cholerae* is able to destroy the viscosity and hence the mechanical protective and lubricating properties of intestinal mucus; this may play a part in facilitating desquamation of the intestinal epithelium (Burnet & Stone, 1947). These and other relationships and their varying significance may aid us to the fuller understanding of the pathogenesis is colibacillosis and allied diseases. This appreciation alone will give us complete control over their harmful effects.

General Classification of Salmonella and *E. coli*

It was customary to classify salmonella by serological means and *E. coli* by biochemical tests. Those strains of *E. coli* recovered from cases of disease are to-day also identified according to their antigenic structure. Salmonella are characterised by "O" somatic heat-stable antigens and "H" flagella heat-labile ones; other surface antigens such as the Vi and M are less important for purposes of classification. In general, salmonella are named, and frequently the name is taken from the place where the particular member was first recovered. Although such names as *Salmonella abortus ovis* and *Salmonella typhimurium* are still used, the geographical tendency has increased with names such as *Salm. reading, Salm. eastbourne* and *Salm. onderstepoort.* Strains of *E. coli* have 3 important diagnostic antigens, somatic ("O"), surface ("K") and flagella ("H"). There are well over 100 known "O" antigens, nearly 100 known "K" antigens, some of which are labelled L, B or A, and about 50 known "H" antigens, and the different serological types of *E. coli* are designated by numbers. Thus we have *E. coli* serotypes named 075.K80, 026.B6 and 0111.B4,

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The Ecology of the Intestinal Bacteria of the Calf.—*Concluded.*

in the milk. As many as 84 per cent. of these calves had tetracycline-resistant *E. coli* in their faeces compared with only 6 per cent. of the group A calves which never received these or other chemotherapeutic agents. The proportion of resistant strains in the group C calves, ones which were still scouring despite drug treatment, was very high, the kind of resistant *E. coli* present being dependent on the particular drug that had been used. The impact of chemotherapy from the herd point of view rather than from that of the individually treated animal within that herd is well illustrated by the high proportion of resistant *E. coli* in the faeces of the group D calves while a comparison of the figure for group E, market calves, with those of group A, control calves, indicates that the widespread use of chemotherapeutic agents in the prevention and treatment of calf scours may well be having an appreciable effect on the ecology of the *E. coli* population of the general calf population.

Finally, if asked what contribution studies on the ecology of the intestinal bacteria have made to the solution of the calf scour problem, I would say they have done little to elucidate its aetiology, have stressed its complexity and have clearly indicated the need for further investigation to determine more precisely the part played in the syndrome not only by *E. coli* but also by the other intestinal bacteria. It is probable that the amount of additional information that can be obtained from studying the faecal flora will be of a limited nature and that more important results will accrue from bacteriological studies carried out in the upper regions of the alimentary tract. Such studies are now in progress but it is too early for us to draw any conclusions from our results.

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and therefore in the matter of nomenclature they differ from salmonella. Other methods of classifying and identifying special types of salmonella and *E. coli* are by the use of bacteriophages and of colicines. Both may be of value in special epidemiological enquiries, but we should beware of the fallacy of regarding even serological types as being immutably stable. Variation occurs under the influence of agencies, some of which are unknown, and genetic factors play a greater part than was at one time suspected.

Natural Distribution of Salmonella and *E. coli*

Notwithstanding the inevitability of the changes which are occurring, some information may be obtained in examining the distribution of some of those salmonella and types of *E.coli* which are known to occur in calves. *Salm. dublin* and *Salm. typhimurium* are probably the 2 common salmonella which infect calves. The first strain of *Salm. dublin* to be separated from other salmonella was recovered from a human patient in Dublin. It was soon realised that this type was frequently of bovine origin and has since been isolated from horses, pigs, sheep and goats as well as from the dog, fox, mink, rat and some poultry. *Salm. typhimurium* on the other hand was originally recognised as a human pathogen of rodent origin. This type is now known to occur in cattle, including calves, horses, sheep, goats, pigs, dogs, cats, poultry and a number of exotic animals. It is probably more widely distributed than any of the other salmonella and is recorded as being responsible for the greater number of outbreaks of salmonella food poisoning in man. On the other hand, cattle may be infected with other salmonella such as *Salm. enteritidis, Salm. bovis-morbificans, Salm. derby* and *Salm. paratyphi B*; the latter was for years regarded exclusively as a human pathogen. A similar picture emerges when one considers the known distribution of some of the serotypes of *E. coli*. Table I gives a selection of the available data.

TABLE I.
DISTRIBUTION OF SOME SEROLOGICAL TYPES OF *E. coli*

Serological type	Original isolation from :—	Subsequent isolation from :—
078 K80	Calf scours	Lamb septicaemia; cat enteritis; piglet (enteritis); bovine mastitis; babies.
035 K ?	Calf scours	Piglet enteritis; dog enteritis.
0101 A	Calf scours	Piglet enteritis.
026 B6	Infantile diarrhoea	Calf scours; piglet enteritis; bovine mastitis; cow's milk; chicken faeces.
055 B5	Infantile diarrhoea	Calf scours; bovine mastitis; bull semen; cow's milk; chicken faeces.
0111 B4	Infantile diarrhoea	Bovine mastitis; piglet enteritis; chicken faeces.

(Collected from observations made by Miss B. Hughes, Dr. T. A. Rees and Dr. J. Taylor, and from Fey (1952, 1953), Orskov and Fey (1954), Sojka *et al.* (1960) and Thompson (1956).).

It is becoming clear, therefore, that serological types of salmonella and of *E. coli* are not confined to one species of animal but are distributed throughout a wide range. This outlook should be linked with the view that adaptation and mutation of bacteria occur more frequently than at one time supposed. The instability of the host-parasite relationship is again forced upon us and the peculiar susceptibility of the calf to many of these Gram-negative rods is our immediate concern. We have returned to the question of the virulence of a particular strain, the mechanism of which may be dependent upon the substrate. Our problem is to determine the exact nature of the substrate and the corresponding enzyme processes.

The Host and Infections with Salmonella and *E. coli*

The substrate is the calf and, so far, our knowledge is largely limited to the resistance conferred by colostrum. We are still ignorant of the reasons why, without this immunity, the calf provides such an excellent medium in its intestinal tract for potentially pathogenic *E. coli*. An active immunity of the dam is known to be transmissible to the offspring, for not only is the gut of the new-born calf permeable to large protein molecules, but the colostrum of the dam may possess the necessary globulins many times in excess of those in her serum. The peak of such concentration appears to be about 3 weeks before calving (Blakemore & Garner, 1956), and once the calf has suckled, the colostral antibodies appear in the blood-stream and reach their maximum titre within 24 hours. Many studies have been made on the immunological aspects of colostrum (see Lovell, 1955; Lovell & Rees, 1960); few have been made on the pathogenesis of colibacillosis of calves.

A calf that is deprived of colostrum does not necessarily die, but the chances of its survival are greatly reduced. Unlike the human infant, the calf acquires no passive immunity from its dam whilst *in utero*; it relies upon the antibodies in the colostrum for protection against the hazards of its new environment. Given sufficient time, a cow produces antibodies against the prevalent organisms in her surroundings and these are transmitted to the calf, which thereby acquires some defence against the organisms in the same surroundings.

Certain races of *E. coli* have a special virulence for the calf and when these are present in the environment, colostrum-feeding and the specific antibody content of the colostrum will determine to a large measure whether the calf will survive. In the absence of any specific protection, the organisms usually induce a septicaemia that is often rapidly fatal. If the calf survives this initial stage, localisation of the infection occurs in some organs and tissues—particularly the serous membranes, the joints and meninges, and the kidneys. The ingestion of colostrum containing specific antibodies, whilst protecting the calf against invasion of its tissues by a particular strain of organism, does not necessarily prevent the massive multiplication of the bacteria in

the lumen of the alimentary tract with associated symptoms of diarrhoea. These cases of White Scours may terminate in death and, at *post-mortem* examination, there is no evidence of septicaemia; the distribution of *E. coli* is limited to the alimentary contents and sometimes the associated lymph nodes. The gross and histological changes seen in these cases *post-mortem* leave no doubt about the profound dehydration that occurs, and this, with all its implications, at least contributes to the fatal outcome of the untreated disease. Evidence of a bacteraemia during the course of the scouring type of the disease may be found with localisation of the infection in the lungs, brain, kidneys or joints; these lesions are not always sufficient to produce death.

During an outbreak of White Scours, the first cases are often not severe and the mortality rate is relatively low; the septicaemic cases usually take the form of a blood-stream infection with polyserositis, and calves with the non-septicaemic type of disease show a protracted period of scouring and illness. Later in the course of the outbreak, acute septicaemias replace the subacute cases and survival time may only be a matter of hours; the non-septicaemic cases scour for no more than 2 or 3 days before they die. Whether by enhancement of the virulence of strains of *E. coli* or by selection of pathogenic strains, organisms of increased virulence populate the surroundings of the calves, and the nature of the environment thus plays an important part in deciding the fate of a calf placed within it.

Any factor which reduces the resistance of the calf will affect the host-parasite relationship in favour of the infecting organism. Adverse housing conditions and nutritional deficiencies, such as a lack of vitamin A and incorrect feeding in the case of pail-fed calves, are sufficient to disturb the delicate balance between the new-born calf and the *E. coli* in its alimentary tract.

The rapid development of a natural resistance of the young calf to *E. coli* infections with increasing age is well known, and the majority of calves that die from White Scours are less than 3 weeks old. This is in marked contrast to salmonella infections which affect young calves and adults alike. Unless a cow has recovered from a salmonella infection it is unlikely that any passive immunity against those particular organisms will be transferred to her offspring. Consequently, untreated cases usually die with a septicaemic infection though the calf may survive long enough for the development, in addition, of localised and severe infections in the lungs, serous cavities, liver and joints. Unlike White Scours and septicaemic *E. coli* infections, a fibrinous enteritis and focal hepatitis frequently occur in salmonella infections, and this may be an indication of the greater pathogenicity of the organisms.

Antibiotic Therapy and Recent Trends

There is a tendency at the moment to use potent drugs for the treatment of calf scours. Ingram, Shillam, Hawkins and Roy (1958) report the reduction in mortality of their experimental calves deprived of colostrum when given chlortetracycline; there was a coincidental improvement in growth rate and these results accord with others and with earlier work by these authors. There are, however, disadvantages in the use of antibiotics because of the increased resistance exhibited by strains. Using experimental calves, Ingram *et al.* (1958) demonstrated an increased resistance to penicillin and chlortetracycline of *E. coli* strains isolated from the small intestine of calves that had received supplements of these antibiotics in their milk during life, compared with strains from calves that had been fed milk without antibiotics. Similarly, Smith and Crabb (1956) have pointed out the change from a streptomycin-sensitive *E. coli* population to a streptomycin-resistant one after oral administration of streptomycin. They also showed that the proportion of strains of *E. coli* resistant to several of the antibiotics was higher than they had experienced in a survey made some 3 to 6 years earlier. Bandaranayake (1960) records similar observations and has been able to demonstrate the increasing resistance to antibiotics of serological types of *E. coli* in mice which had been receiving the corresponding antibiotics in their drinking water. This confirms the view that resistance can occur *in vivo* for it was possible to identify the serological types at each stage of the experiments. Furthermore, it was shown that whereas low degrees of resistance were relatively unstable, high degrees tended to persist. The effect of the emergence of resistant strains upon the epidemiology of calf disorders is debatable. It limits the use of specific remedies, and antibiotic resistant strains are being found in natural outbreaks of calf diseases (Gould, 1958). There may be a more general effect for salmonella infections of calves are becoming increasingly common, and the proportion of cases of bovine mastitis due to Gram-negative rods now accounts for about 10 per cent. The apparent increase in salmonella infections may possibly be associated with infected bone meal and other organic materials that are imported into this country (Report 1959; Dixon & Wilson, 1960). The latter authors do not see any reason to believe that the fertilisers containing superphosphate of the kind which they examined are important in the epidemiology of salmonella disease in man and animals; their presence in animal feeding-stuffs is probably more serious. At the moment it is clear that, as far as *E. coli* infections are concerned, an attack upon the infection itself is less logical than the giving of some help to the host. The disease is largely due to a breakdown in a host-parasite relationship which would be an amicable one were it not for the interference of man.

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(4) Antibiotics and Calf Diarrhoea

BY

R. G. DALTON, E. W. FISHER, and W. I. M. McINTYRE

University of Glasgow Veterinary School

SUMMARY. Observations, on 280 calves, of the effect of antibiotics on the incidence and severity of diarrhoea are described. It has been shown that some antibiotics can markedly reduce the incidence of diarrhoea under certain conditions. The implications of this finding are briefly discussed.

Introduction

DURING the last 20 years the administration of antibiotics to calves as a feed supplement and as a therapeutic agent in the treatment of diarrhoea has been widely practised. The many studies that have been made on the value of antibiotics as feed supplements for calves have been reviewed by Lassiter (1955). From this review Lassiter drew the following conclusions on the value of the antibiotics as a feed supplement for the calf. Oxytetracycline and chlortetracycline are the only antibiotics on which sufficient study has been made to warrant any valid conclusions; the growth rate of calves may be stimulated by 10 per cent. to 30 per cent. during the first 4 months of life by feeding a supplement of either of these, most of the increased growth occurred during the first 2 months of life; and, when fed as a supplement they also appear to reduce the incidence of calf diarrhoea, to increase the feed consumption and efficiency, and to improve the overall condition of the animal. Lassiter recommended feeding these antibiotics at a level of 15-20mg. per 100 lbs. body weight per day, approximately 1/25th of the normal therapeutic dose.

Kon *et al.* (1953) reported that penicillin reduced the incidence of calf diarrhoea; on the other hand Knodt and Ross (1953) found that penicillin increased the incidence. Gardner *et al.* (1952) and Voelker and Jacobson (1953) observed that penicillin had no effect on the incidence of calf diarrhoea.

Fox (1952) stated that calves with diarrhoea given 0.5g. per os or 0.5g. by injection of streptomycin usually responded well to a single treatment. In his study, streptomycin appeared to be more successful than treatment with sulphathalidine. The treatment with streptomycin of acute calf diarrhoea and its prophylactic value in preventing the disease when given to new born calves, has been described by Henderson and McKay (1949). On farms which had previously had a high mortality rate the incidence of disease was considerably reduced following the administration, at birth and for the next 4 to 6 days, of daily doses of 0.25g. of streptomycin orally.

Dickson (1954) has described the successful treatment of an outbreak of salmonellosis in young calves with neomycin. In a study by Clark Osborne *et al.* (1959) on 3 groups, each of 21 calves, the incidence of diarrhoea was reduced by both neomycin and furamazone but the death rate by the latter drug only.

Bortree *et al.* (1952) conducted some field trials with chlortetracycline. In one outbreak of diarrhoea investigated by these workers, of 58 cases of diarrhoea which were treated with oral chlortetracycline 51 responded immediately to treatment and 5 gradually. Two of the calves did not respond to treatment and eventually died. In another investigation by these workers, 67 calves were given one 500 mg. tablet of chlortetracycline at birth. Forty of these calves remained healthy and 27 developed diarrhoea of varying intensity. Twenty-one of the calves affected with diarrhoea responded to a single treatment of 500 mgs. of chlortetracycline but 6 required further treatment, 1 of those dying.

Pearson (1954) described the therapeutic and prophylactic use of oxytetracycline in the control of field cases of calf diarrhoea in Northern Ireland. In this work, of 41 clinical cases of calf diarrohea which were treated by giving two daily doses of 0.5g. of oxytetracycline, 40 completely recovered within 36 hours of the administration of the antibiotic. When 21 calves on 6 other farms were given two doses of 0.5g. of oxytetracycline within the first 48 hours of life none developed diarrhoea, although other untreated animals on the same farms became affected with diarrhoea.

The effect of chemotherapy on the number of *Escherichia coli* in the faeces of calves has been described recently by Williams-Smith and Crabb (1960). The greatest and most prolonged reduction in the coliform faecal count in healthy calves occurred after a single dose of streptomycin or neomycin, such effects being obtained in all the calves treated with these drugs. Treatment with polymixin consistently resulted in a marked reduction; oxytetracycline, chlortetracycline, sulphadimidine and phthalylsulphathiazole had a considerable depressing effect on the *E. coli* faecal count, although in a small proportion of calves no decrease was found. The administration of chloramphenicol to 6 calves had no effect on the

Infection by *Escherichia coli* and Salmonella.—*Concluded*

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coliform count and similar results were found when calves were given furazolidone and furamazone. These workers also showed that the continued daily administration of streptomycin, neomycin and polymixin had a very marked depressant effect on the growth of faecal *E. coli*. A much greater depressant effect was noted when the tetracyclines and the sulphonamides were given daily than when given in a single dose. Only a slight depressant effect was noticed when chloramphenicol, furamozone and furazolidone were given twice daily.

In the present paper our observations on the effect of 9 different preparations of 6 antibiotics, of 1 sulphonamide and of multiple feeding on the incidence of calf diarrhoea are described.

Methods

During the years 1956-1960 ten batches of male Ayrshire calves, totalling 280 were purchased from Paisley Market. Thousands of surplus calves are sold at this market each year. Care was taken to select only lively and healthy calves and those showing any evidence of diarrhoea, pneumonia or joint ill were rejected. Furthermore only calves with dry umbilical cords were chosen thus ensuring that the calves were at least 3 days old. While it was impossible to be sure of the upper age limit of the calves, every effort was made to minimise the weight range in each batch. As most farmers are eager to sell their surplus bull calves at the earliest possible opportunity it is likely that the majority of the calves purchased were less than 7 days old.

On the afternoon of the sale the calves were transported to the Veterinary Hospital and housed in separate galvanised calf houses approximately 6 x 4 x 5 ft. in size. The calf houses had been previously cleaned and disinfected before use and a generous bed of oat straw was provided. The calves were fed on 2 pints of either 'Ostermilk II' (Glaxo Laboratories Ltd.), or cow's milk heated to a temperature of 35 deg.—38 deg. C. The Ostermilk was purchased as a powder and added to water at the rate of 1.5 lbs. of powder to one gallon of water. Its composition was very similar to the cow's milk as shown below.

% Composition	Ostermilk	Cow's milk
Carbohydrate	4.9	4.8
Fat	3.5	3.9
Protein	3.4	3.4
Salt	0.7	0.7
Dry matter	13.0	12.8

The calves were divided into groups of 10 animals in each of the 10 experiments. The calves were arranged in groups at random in the first 7 experiments, and randomised on a weight basis in the last 3 experiments. In each experiment one of the groups of calves was given no treatment and acted as a control, while the other groups were given different treatments. In all the experiments, apart from experiments 8 and 10, the diet of the calves consisted of 3 pints of 'Ostermilk' prepared as previously described and given twice daily, between 8 and 9 a.m. and again between 4 and 5 p.m. In Experiment 8 two of the 3 groups of calves were fed as above, but the other group of calves was fed 3 times daily on 2 pints of 'Ostermilk' at approximately 8 a.m., 12 noon and 4 p.m. In Experiment10, in which there were 3 groups of calves, 15 calves were fed twice daily on 3 pints of 'Ostermilk' and the other 15 on 3 pints of cow's milk. Five calves of each group of 15 were given chlortetracycline.

Each calf was provided with a separate feeding bucket which was washed with cold water after each meal but not sterilised. From Experiment 3 onwards when a calf refused to take all its 'Ostermilk' or cow's milk the remainder was given by stomach tube at each feeding time until the calf began to drink all its milk or died.

Every second day the calf houses were cleaned out, but not disinfected, and clean straw bedding introduced. In the early experiments great pains were taken to limit the amount of handling of the calves. The stockmen used long handled rakes for cleaning and bedding purposes and entry into the calf houses was avoided whenever possible. In later experiments, however, these efforts were abandoned because of the assistance required of the stockmen in taking the many samples of blood and faeces which were collected.

The treatment with each antibiotic was begun on the morning after admission. All treatments were given twice daily at feeding times and continued for 14 days until the end of the experiment. The antibiotics were given orally as a drench or in tablet form, or by intramuscular injection.

All calves were weighed before treatment began and every second day thereafter, apart from Experiment 1 in which the calves were weighed weekly. The weighings were carried out about 2 hours after the morning feed, weights being read to the nearest pound.

During the fortnight of each experiment, a daily examination of the type of faeces passed by each calf was made about an hour after they had been given the morning feed. At this time most of the calves had defaecated or did so when disturbed.

The voided faeces were classified into 4 categories as follows:

Normal Faeces

These were firm in consistency and well formed, often quite dark in colour and small in volume. They were passed daily or every second day.

Diarrhoea 1 *Faeces*

These were partly fluid and of an increased volume compared with normal faeces and were passed once or twice daily.

Diarrhoea 2 *Faeces*

In this category the faeces were fluid and contained only a few solid pieces; they were increased markedly in volume, often smelt offensively and were passed frequently during the day.

Diarrhoea 3 *Faeces*

These were completely fluid in character, of copious volume and evil smelling. They were light in colour and were passed frequently during the day.

often dribbling from the rectum of the recumbent calf.

This classification of diarrhoea is used throughout the presentation of results in this paper. A similar classification of the faeces of calves was described by Blaxter and Wood (1953). In Experiment 2 the temperatures and pulse rates of the calves were recorded.

Results

In presenting the results in each experiment the following criteria are recorded in each Table for the purpose of comparison between the treated and the control groups.

1. The number of calves in each group of 10 which died.
2. The number of calves in each group of 10 which became affected with diarrhoea at some time during the fortnight of the experiment.
3. The number of days during the fortnight of the experiment on which the calves in a group were observed to pass faeces of the different types already described, i.e. D1, D2 and D3.
4. The total number of diarrhoea days in each group were obtained by the addition of the number of D1, D2 and D3 days.
5. When a calf died, the day of its death and the number of days remaining in the experiment out of the 14 were called death days, and the total of death days for each group was obtained by the addition of the death days for all the calves which died.
6. A grand total was prepared by adding together the diarrhoea and the death days for each group in order to compare the broader effect of treatment in preventing both diarrhoea and death.
7. A statistical analysis has been applied by the following method to determine if there was any significant difference in the incidence of diarrhoea and death in the treated and in the control group in each experiment. For each calf the proportion 'd',

$$\frac{\text{No. of Diarrhoea days}}{\text{No. of days in Experiment}}$$

was determined. If a calf died during the experiment the value of 'd' was taken as = 1, death being considered to be as serious as 14 days of diarrhoea. From the value of 'd' obtained for each calf the value of 'x' $= \sin^{-1}\sqrt{d}$. was calculated. From the value of 'x' obtained for each calf the mean value of 'x' for the group was determined. A 't' test was then applied to determine if there value of 'x' for the group was determined. A 't' test was then applied to determine if there was a statistically significant difference between the mean values of 'x' for the treated and the control groups. The 't' value for each treated group thus obtained and the level of significance 'p' are recorded in each table.
8. The mean body weight, on the first day of the experiment, of the calves in each group which lived throughout the fortnight of the experiment.
9. The difference in the body weight on the first and on the last day of the experiment was calculated for each calf. In the tables are shown the mean values of the weight changes for the calves in each group that lived throughout the fortnight of the experiment.
10. The mean weight change for each group of treated calves was compared with the control group to determine if there was a statistically significant difference between them. The table shows the 't' value thus obtained and the level of the significance 'p'.

The results obtained in Experiment 1 are shown in Table I.

TABLE I
EXPERIMENT I
Date : 19.3.56 to 1.4.56.
The effects of streptomycin as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3	Group 4
No. of calves which died	2	0	1	0
No. of calves with diarrhoea ...	10	9	10	10
Diarrhoea 1 day ...	24	32	33	35
Diarrhoea 2 days...	13	17	16	21
Diarrhoea 3 days...	37	2	4	18
Total diarrhoea days	74	51	53	74
Death days ...	17	0	4	0
Total diarrhoea and death days ...	91	51	57	74
"t" for statistical analysis ...	—	2·72	2·62	1·3
"p" for statistical analysis ...	—	2·0%	2·0%	n.s.
Weight of calves on 1st day	79±8	80±7	80±11	81±8
Mean weight change of calves ...	−3·7±4·4	−1·7±7	−0·1±8·5	−1·5±6·2
"t" for weight change	—	1·0	1·0	0·7
"p" for weight change	—	n.s.	n.s.	n.s.

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth as a drench 0·23 g. streptomycin (Streptovex, Glaxo Laboratories Ltd.).
Group 3. Received twice daily by mouth as a drench 0·25 g. streptomycin (Streptovex 1, Glaxo Laboratories Ltd.).
Group 4. Received twice daily by intramuscular injection 0·25 g. streptomycin (Strepolin 33, Glaxo Laboratories Ltd.).

It will be noticed that all the untreated calves were affected with diarrhoea at some time during the experiment and that 2 of the 10 calves died. Of the 20 calves which were given streptomycin by mouth only one was not affected by diarrhoea but only one died. The total diarrhoea and death days in the 2 groups receiving streptomycin by mouth were 51 and 57 respectively, which is significantly (at the 2 per cent level) lower than the total of 91 days in the untreated group. Streptomycin also reduced the severity of the disease. Of the joint total of 108 diarhoea and death days for the 20 calves in the 2 treated groups, there were only 6 D3 days and 4 death days, compared with a total of 91 days in the 10 control calves, of which 37 were D3 days and 17 were death days.

Between the 2 groups receiving oral streptomycin there was no significant difference in the total diarrhoea and death days.

Streptomycin given by intramuscular injection did not prevent diarrhoea in any of the treated calves, and the total of 74 diarrhoea and death days in the group was not significantly lower than the total of 91 days in the untreated group. Streptomycin given parenterally did, however, reduce the severity of the disease. None of the treated calves died but 2 of the controls did, and of a total of 74 diarrhoea and death days there were only 18 D3 days and no death days in the treated group, compared with 37 D3 days and 17 death days out of a total of 91 diarrhoea and death days in the control group.

There was no significant increase in the growth rate of any of the groups of treated calves in Experiment 1.

When streptomycin was again administered orally and parenterally to calves in Experiment 2, the results of which are shown in Table 2, the effects of the antibiotic on the incidence and the severity of the diarrhoea were less apparent than those seen in the previous experiment. All the treated calves were affected with diarrhoea, and while there were no

TABLE II

EXPERIMENT II

Date : 8.10.56 to 21.10.56

The effects of oral and parenteral streptomycin as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3
No. of calves which died ...	1	0	0
No. of calves with diarrhoea	10	10	10
Diarrhoea 1 day	16	24	28
Diarrhoea 2 days	23	18	24
Diarrhoea 3 days	9	13	11
Total diarrhoea days ..	48	55	63
Death days	10	0	0
Total diarrhoea and death days	58	55	63
"t" for statistical analysis	—	0·7	0·13
"p" for statistical analysis	—	n.s.	n.s.
Weight of calves on 1st day	74±4	82±7	74±3
Mean weight change of calves	+4·0±7	+3·1±2·8	±4±3·8
"t" for weight change ...	—	0·4	0·0
"p" for weight change ...	—	n.s.	n.s.

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth as a drench 0·25 g. streptomycin (Streptovex, Glaxo Laboratories Ltd.).
Group 3. Received twice daily by intramuscular injection 0·25 g. streptomycin (Strepolin 33, Glaxo Laboratories Ltd.).

deaths in the 2 groups receiving treatment and one in the untreated group, the total diarrhoea and death days in the treated groups were not significantly reduced by streptomycin. The antibiotic also failed to reduce the severity of the disease as it had done previously. On this occasion the incidence of the diarrhoea in the untreated group in Experiment 2 was much lower than in Experiment 1, the total diarrhoea and death days being 48 as compared with 78 in the untreated group of Experiment 1. Again, there was no significant increase in the growth rate of the treated groups.

In Experiment 3, the results of which are given in Table 3, all the control calves and all the calves given neomycin by mouth became affected with diarrhoea, while only 7 of the 10 calves given oxy-

TABLE III

EXPERIMENT III

Date : 22.10.57 to 4.11.57

The effects of neomycin and oxytetracycline as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3
No. of calves which died ...	3	1	0
No. of calves with diarrhoea	10	10	7
Diarrhoea 1 days	17	32	12
Diarrhoea 2 days	25	30	9
Diarrhoea 3 days	31	27	2
Total diarrhoea days ...	73	89	23
Death days	24	3	0
Total diarrhoea and death days	97	92	23
"t" for statistical analysis	—	0·68	5·06
"p" for statistical analysis	—	n.s.	0·1%
Weight of calves on 1st day	78±10	75±6	72±8
Mean weight change of calves	−2·1±6·5	+0·4±3·4	+3·8±5·3
"t" for weight change ...	—	0·94	1·94
"p" for weight change ...	—	n.s.	10–5%

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth as a drench 250 mg. neomycin sulphate (Neomin Oral Liquid, Glaxo Laboratories Ltd.).
Group 3. Received twice daily by mouth 250 mg. oxytetracycline (Terramycin Animal Formula tablets, Pfizer Ltd.).

tetracycline were affected. Three of the control calves and one of the calves given neomycin died, but there were no deaths in the group given oxytetracycline. There was no significant difference in the total diarrhoea and death days between the control group, which had 97 days and the group given neomycin, which had 92 days.

Oxytetracycline reduced very significantly (at the 0.1 per cent. level) the total diarrhoea and death days. The treated animals in this group had a total of only 23 days of which there were no death days and only two D3 days, compared with a total of 97 days in the control group, of which 31 were D3 days and 24 were death days.

The untreated calves in this experiment lost weight; the group which received neomycin maintained a fairly constant weight; and the group which received oxytetracycline increased in weight significantly (approaching the 5 per cent. level).

When the treatment with oxytetracycline by mouth was repeated in Experiment 4, the results of which are given in Table 4, a result similar to that in the previous experiment was obtained. On this occasion, however, one of the treated calves died, although there were no deaths in the untreated group and all the calves in both groups became affected with diarrhoea. The treated calves had a total of 30 diarrhoea and death days of which there were nine death days, but only three D3 days, compared with a total of 86

TABLE IV

EXPERIMENT IV

Date : 3.6.58 to 16.6.58

The effects of oxytetracycline as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2
No. of calves which died ...	0	1
No of calves with diarrhoea ...	10	7
Diarrhoea 1 days	33	11
Diarrhoea 2 days	35	7
Diarrhoea 3 days	18	3
Total diarrhoea days	86	21
Death days	—	0·9
Total diarrhoea and death days ...	86	30
"t" for statistical analysis ...	—	3·7
"p" for statistical analysis ...	—	0·2%
Weight of calves on 1st day ...	70±5	73±9
Mean weight change of calves ...	−3·4±3·7	+0·4±3·9
"t" for weight change	—	2·06
"p" for weight change	—	5%

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth 250 mg. oxytetracycline (Terramycin Animal Formula tablets, Pfizer Ltd.)

diarrhoea and death days in the control group, of which number there were no death days and 18 D3 days. The difference in the total diarrhoea and death days between the 2 groups was again significant (at the 0.2 per cent. level). At the end of the experiment the treated calves were significantly (at the 5 per cent. level) heavier than the controls.

In Experiment 5, in which the treatment with oxytetracycline by mouth was again repeated, it will be seen from Table 5 that one of the treated calves did not become affected with diarrhoea at all and only 1 died, while in the control group, all the calves became affected with diarrhoea and 3 died. Although

TABLE V

EXPERIMENT V

Date : 26.1.59 to 8.2.59

The effect of oxytetracycline as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2
No. of calves which died	3	1
No. of calves with diarrhoea ...	10	9
Diarrhoea 1 days	20	11
Diarrhoea 2 days	12	7
Diarrhoea 3 days	14	4
Total diarrhoea days	46	22
Death days	21	13
Total diarrhoea and death days ...	67	35
"t" for statistical analysis ...	—	1·96
"p" for statistical analysis ...	—	10–5%
Weight of calves on 1st day ...	82±6	75±6
Mean weight change of calves ...	−10·1±2·9	−8·3±3·0
"t" for weight change	—	1·09
"p" for weight change	—	n.s.

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth 250 mg. oxytetracycline (Terramycin Animal Formula tablets, Pfizer Ltd.).

the total of 35 diarrhoea and death days in the treated group was much lower than the 67 days in the control group, the significance (at the 5 per cent. level) of the results was not as great as that obtained in previous experiments. There was no significant difference in the rate of growth between the treated and control groups in Experiment 5.

In marked contrast to the significant results obtained with oxytetracycline when given orally, the

TABLE VI

EXPERIMENT VI

Date : 4.6.58 to 17.6.58

The effects of oxytetracycline as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2
No. of calves which died	2	2
No. of calves with diarrhoea ...	10	10
Diarrhoea 1 days	28	19
Diarrhoea 2 days	24	30
Diarrhoea 3 days	27	22
Total diarrhoea days	61	57
Death days	18	14
Total diarrhoea and death days ...	79	71
"t" for statistical analysis ...	—	0·36
"p" for statistical analysis ...	—	n.s.
Weight of calves on 1st day ...	73±8	86±5
Mean weight change of calves ...	−1·2±4·9	−1·9±4·9
"t" for weight change	—	0·26
"p" for weight change	—	n.s.

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by intramuscular injection 250 mg. oxytetracycline (Terramycin Injectable Solution, Pfizer Ltd.).

TABLE VII

EXPERIMENT VII

Date : 10.2.59 to 23.2.59

The effects of penicillin and chlortetracycline as prophylactics on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3
No. of calves which died	6	4	3
No. of calves with diarrhoea	10	8	10
Diarrhoea 1 day	21	20	17
Diarrhoea 2 days	17	10	5
Diarrhoea 3 days	17	10	23
Total diarrhoea days ...	55	40	45
Death days	25	20	16
Total diarrhoea and death days	80	60	61
"t" for statistical analysis	—	1·79	0·13
"p" for statistical analysis	—	10%	n.s.
Weight of calves on 1st day	71±3	70±5	75±5
Mean weight change of calves	−4·7±1·7	−2·9±3·6	−5·3±4·6
"t" for weight change ...	—	0·2	0·1
"p" for weight change ...	—	n.s.	n.s.

n.s. = not significant

Group 1. No treatment.
Group 2. Received twice daily by mouth 250,000 I.U. penicillin G (D.C.L. Biochemicals Ltd.).
Group 3. Received twice daily by mouth 250 mg. chlortetracycline (Aureomycin Soluble Oblets, Cyanamid of Great Britain Ltd.).

effects produced by parenteral administration of the drug in Experiment 6 were negligible, as will be seen from the results shown in Table 6.

There was no appreciable difference in the incidence and the severity of the disease between the treated and the untreated groups. In both groups, all the calves were affected and 2 in each group died. The total diarrhoea and death days were also similar, the controls having a total of 79 of which there were 27 D3 days and 18 death days, and the treated group having a total of 71, of which there were 22 D3 days and 14 death days. There was no significant difference in the growth rate between the 2 groups.

In Experiment 7 there was an exceptionally heavy death rate in all of the groups. The results are given in Table 7.

Six of the control group, 4 of the calves which received penicillin, and 3 of the calves which received chlortetracycline died. Two of the calves which received penicillin did not become affected but all of the calves which received chlortetracycline, and all of the calves in the control group developed diarrhoea. There was a slightly significant (at the 10 per cent. level) difference in the total diarrhoea and death days between the control group and the penicillin-treated group, but not the chlortetracycline treated group. The treatments did not reduce the severity of the disease nor produce any significant difference in the rate of growth of the treated calves.

When the treatment with chloreteracycline by mouth was repeated in Experiment 8, the results were of similar significance to those obtained with oxytetracycline. The results are shown in Table 8.

TABLE VIII

EXPERIMENT VIII

Date : 18.1.60 to 1.2.60

The effects of chlortetracycline as a prophylactic and multiple feeding on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3
No. of calves which died ...	4	0	4
No. of calves with diarrhoea	10	8	10
Diarrhoea 1 days	10	13	19
Diarrhoea 2 days	10	8	17
Diarrhoea 3 days	20	4	16
Total diarrhoea days ...	40	25	52
Death days	31	0	31
Total diarrhoea and death days	71	25	83
"t" for statistical analysis	—	3·29	0·3
"p" for statistical analysis	—	1%	n.s.
Weight of calves on 1st day	73±10	74±8	80±4
Mean weight change of calves	−1·6±3·8	−1·7±2	−7±5·2
"t" for weight change ...	—	0·0	—
"p" for weight change ...		n.s.	n.s.

n.s. = not significant

Group 1. No treatment. Fed three pints of "Ostermilk" twice daily.

Group 2. Received twice daily by mouth 250 mg. chlortetracycline (Aureomycin Soluble Oblets, Cyanamid of Great Britain Ltd.).

Group 3. No treatment. Fed two pints of "Ostermilk" three times daily.

From the Table, it will be seen that 2 of the calves given chlortetracycline did not develop diarrhoea and none died, whereas all the calves in the control group became affected and 4 died. Chlortetracycline also significantly (at the 1 per cent. level) reduced the total diarrhoea and death days and reduced the severity of the diarrhoea. Of the total 25 diarrhoea and death days in the treated group there were no death days and only 4 D3 days compared with a total of 71 in the control group of which 31 were death days and 20 D3 days. In contrast to this effect, there was no significant difference in growth rate between the 2 groups.

There was no significant difference in the number of deaths or in the total diarrhoea and death days in the calves fed three times per day compared with those fed only twice daily. Neither was there any significant difference in the rate of growth.

The death rate in the calves given chloromycetin in Experiment 9, the results of which are shown in Table 9, was half that of the untreated calves; 2 died compared with 4, while 3 of the calves which received phthalylsulphathiazole also died.

TABLE IX

EXPERIMENT IX

DATE : 8.3.60 to 21.3.60

The effects of chloromycetin and phthalylsulphathiazole as prophylactics on the incidence and severity of diarrhoea in calves and on their growth.

	Group 1	Group 2	Group 3
No. of calves which died ...	4	2	3
No. of calves with diarrhoea	10	10	10
Diarrhoea 1 days	14	10	18
Diarrhoea 2 days	15	13	7
Diarrhoea 3 days	49	13	14
Total diarrhoea days ...	78	36	39
Death days	29	20	21
Total diarrhoea and death days	107	56	60
"t" for statistical analysis	—	2·75	1·89
"p" for statistical analysis	—	2%	10%
Weight of calves on 1st day	65±11	74±6	76±8
Mean weight change of calves	−12·3±6·5	−4±2·8	−4±3
"t" for weight change ...	—	4·0	4·0
"p" for weight change ...		0·1%	0·1%

n.s. = not significant

Group 1. No treatment.

Group 2. Received twice daily by mouth 250 mg. chloromycetin (Chloromycetin Vetrettes 500 mg. Parke Davis & Co. Ltd.).

Group 3. Received twice daily by mouth 2·5 gm. phthalylsulphathiazole (Thalazole, May & Baker Ltd.).

All the calves in this experiment were affected with diarrhoea. In the group which received chloromycetin orally there were 56 diarrhoea and death days, which was significantly (at the 2 per cent. level) lower than the total of 107 days in the control group. The results obtained with the phthalylsulphathiazole were not significantly different from the control calves, for although there were only 60 diarrhoea and death days, the 3 deaths in this group made the result on the statistical analysis used only slightly significant (at the 10 per cent. level). The chloromy-

cetin and the phthalylsulphathiazole also reduced the severity of the disease as well as the overall incidence, in that there were fewer death days and D3 days in the treated groups. Although all the calves in this experiment lost weight, the chloromycetin and phthalylsulphathiazole treated groups had significantly (at 0.1 per cent. level) greater weights than the control group, at the end of the experiment.

The results of Experiment 10 are shown in Table 10. In this experiment, 10 calves were treated with chlortetracycline, 5 of which were fed with raw cow's milk and 5 with 'Ostermilk'. Two other groups, each of 10 calves were not treated, 1 group being fed 'Ostermilk' and the other raw cow's milk. When the incidence of diarrhoea and death days in the 5 treated calves being fed cow's milk was compared with that in the untreated 10 calves being similarly fed, it was found to be significantly (at 0.2 per cent. level) lower. There was a similarly lowered incidence in the treated group being fed 'Ostermilk' which was significant (at the 0.1 per cent. level). Three of the 10 treated calves did not develop diarrhoea. The treatment also reduced the severity of the diarrhoea; in the 10 treated calves there was a total of 16 diarrhoea and death days, of which there were no death days and only two D3 days, while in the 'Ostermilk' fed group and the cow's milk fed group there were totals of 84 and 48 respectively, of which there were 12 and 8 death days and 16 and 6 D3 days, respectively. The growth rate was significantly (at the 5 per cent. level) greater in the calves given chlortetracycline than in either of the untreated groups.

TABLE X

EXPERIMENT X

Date : 7.6.60 to 20.6.60

The effects of chlortetracycline as a prophylactic on the incidence and severity of diarrhoea in calves and on their growth rate.

	Group 1	Group 2	Group 3a	Group 1b
No. of calves which died	2	1	0	0
No. of calves with diarrhoea ...	10	10	5	2
Diarrhoea 1 days	23	26	11	3
Diarrhoea 2 days	33	10	3	0
Diarrhoea 3 days	16	6	2	0
Total diarrhoea days	72	42	16	3
Death days ...	12	8	0	0
Total diarrhoea and death days ...	84	48	16	3
"t" for statistical analysis ...	—	1·78	2·77	3·18
"p" for statistical analysis ...	—	10%	1%	0·2%
Weight of calves on 1st day	72±6	71±6	70±6	72±6
Mean weight change of calves ...	−3±4·5	+2±2·7	+4±4·4	+7±4·4
"t" for weight change	—	2·6	2·56	2·42
"p" for weight change	—	2%	5%	5%

Group 1. 10 calves. Fed "Ostermilk." No treatment.
Group 2. 10 calves. Fed raw cow's milk. No treatment.
Group 3a 5 calves. Fed "Ostermilk." Received twice daily by mouth 250 mg. chlortetracycline (Aureomycin soluble oblets Cyanamid of Great Britain Ltd.).
Group 3b. 5 calves. Fed raw cow's milk. Received twice daily by mouth 250 mg. chlortetracycline (Aureomycin soluble oblets Cyanamid of Great Britain Ltd.).

The values of "t" and "p" given under Group 2 represent a comparison between Groups 1 and 2 ; those under Group 3a represent a comparison between Groups 1 and 3a ; and those under Group 3b represent a comparison between Groups 2 and 3b.

In all the experiments described, the calves appeared to be affected by the same type of disease syndrome. Generally speaking they could be classified into 3 groups, viz. those which developed severe diarrhoea and died after a few days, those which developed severe diarrhoea and eventually recovered, and those which developed only mild diarrhoea and recovered within a few days.

Most calves became affected with diarrhoea during the first week of the experiment and the disease reached its maximum severity and incidence during the early part of the second week. Thereafter a gradual recovery took place and by the end of the fortnight, most of the surviving calves were voiding normal faeces.

The overall mortality in the untreated groups of calves was 28 per cent. varying from an absence of death in some groups to as many as 6 out of 10 in another. These calves died on average at the 8th ± 3 days of the experiment following an average of 4 ± 2 days of diarrhoea. The calves which died, invariably lost weight, the mean loss of weight for the 24 untreated calves which died being 8 ± 6 lbs., which represents a loss of approximately 10 per cent. of their initial mean body weight of 76 lbs.

The calves which died showed no significant elevation of body temperature, but showed some decrease a variable time before death. In Table II are shown the rectal temperatures and arterial pulse rates of the calves in Experiment 2. The measurements are grouped according to the type of faeces the calf passed on the day of the recording. From this Table it is obvious that there was no correlation between either rectal temperature or pulse rate and the severity of the diarrhoea.

TABLE XI

THE TEMPERATURE AND ARTERIAL PULSE RATES OF CALVES IN EXPERIMENT 2

	Normal	Diarrhoea 1	Diarrhoea 2	Diarrhoea 3
Temperature °F.	102·0±0·6 (136)	102·1±0·7 (41)	102·4±0·6 (45)	102·5±0·6 (23)
Pulse rate per min.	95±15 (131)	96±15 (39)	91±15 (46)	92±13 (29)

The figures in parenthesis are the number of observations made.

In the calves which were severely affected, but did not die, there was a general tendency to lose weight initially and to regain it as soon as the diarrhoea ceased.

As none of the control calves remained completely unaffected with diarrhoea it was impossible to

measure the growth rate of normal calves fed on the diet provided. However, 11 of these calves had mild diarrhoea for 4 days or less and the average weight of these calves measured on alternate days is given in Table 12.

TABLE XII

THE MEANS AND STANDARD DEVIATION OF THE BODYWEIGHTS IN LB. OF 11 CONTROL CALVES EACH WITH FOUR OR LESS DIARRHOEA DAYS

Day of Expt.	1	3	5	7	9	11	13
Mean ...	75	76	77	75	74	75	75
S.D.	±7	±8	±7	±7	±7	±7	±7

It can be seen that the weights remained fairly constant over the 14 days and that there was no gain at the end of the period.

The mortality rate in the untreated calves in the experiments was highest in the months of January, February and March, when 19 (38 per cent.) of the 50 untreated calves died; in the months of June and July, 4 (13 per cent.) of 30 untreated calves died; in the months of October and November, 4 (20 per cent.) of 20 untreated calves died.

In table 13 are given the percentage levels of significance at which the totals of the diarrhoea and death days differed in the treated and untreated groups.

TABLE XIII

PER CENT. LEVELS OF SIGNIFICANCE IN THE DIFFERENCE BETWEEN THE TOTAL DIARRHOEA AND DEATH DAYS IN THE TREATED GROUPS AND THEIR RESPECTIVE CONTROL GROUPS

Treatment	Per cent. level of significance			
Streptomycin orally	2	n.s.		
Streptomycin I orally	2			
Streptomycin parenterally ...	n.s.	n.s.		
Neomycin orally	n.s.			
Chloromycetin orally	2			
Penicillin orally	10			
Chlortetracycline orally	n.s.	1	1	0·2
Oxytetracycline orally	0·1	0·2	10–5	
Oxytetracycline parenterally ...	n.s.			
Phthalylsulphathiazole orally ...	10			
Feeding three times daily ...	n.s.			
Feeding raw cow's milk ...	10			

Because of the different numbers of experiments carried out with each antibiotic it is impossible to use these results as a comparison of the relative effectiveness of each product. Nonetheless, it is worth noting that on 3 of 4 occasions on which chlortetracycline was given orally, and on 2 of 3 occasions on which oxytetracycline was given orally highly significant results were obtained.

Discussion

In this study it has been shown that a number of antibiotics can significantly reduce the incidence of diarrhoea and death in young calves, but it must be emphasised that the treatments were given twice daily on 14 successive days and at full therapeutic dose levels and that the calves were housed in separate pens. Furthermore, of the 2 products which have been used most frequently, chlortetracycline failed to produce a significant result on one occasion and oxytetracycline produced a result on one occasion which was only slightly significant. None of the antibiotics used in this study, therefore, can be expected to control diarrhoea in calves in all circumstances. Nonetheless, as a result of this work and that of many others, it is obviously of great economic importance to the dairying industry to continue to explore the use of these antibiotics in experimental animals and in the field.

The mode of action of antibiotics in reducing the incidence of diarrhoea is open to speculation. The work of Williams-Smith and Crabb (1960) has shown that chemotherapy can markedly reduce the numbers of *E. coli* in the faeces and it is possible that this factor alone is sufficient to reduce the incidence of diarrhoea.

The failure of streptomycin and oxytetracycline to reduce the incidence of diarrhoea when given parenterally could be explained by the fact that they are not excreted into the lumen of the intestine and do not therefore come in contact with the organisms. If this were true it would provide some indirect evidence for the supposition that excessive numbers of *E. coli* in the intestine play an important part in the production of severe diarrhoea in the calf.

The exact role of *E. coli* in the etiology of calf diarrhoea is not fully understood, but it seems reasonable to suggest that they play their part in converting cases of mild diarrhoea into a more severe form, their rapid multiplication having been facilitated by the too early appearance in the large intestine of food passed on too rapidly by the small intestine. Even if this hypothesis were true, it still leaves unexplained the initial cause of the disturbance and the way in which the appearance of large numbers of *E. coli* give rise to excessive diarrhoea.

In this study and in many others reported, it was impossible to eliminate the possibility that a virus, such as that of mucosal disease caused some of the cases of diarrhoea. This remains as a complicating factor in any study of calf diarrhoea undertaken.

If antibiotics reduce the incidence of diarrhoea in calves by reducing the numbers of *E. coli* in the intestinal tract then their failure to do so on some occasions could be explained by the presence of resistant strains of organisms to the particular antibiotic being used. It would also make it appear more likely that the wider spectrum antibiotics would have the greatest overall effect under varying conditions. Nonetheless, it has been shown that even they can fail to alter significantly the incidence of diarrhoea under some circumstances.

The fact that feeding calves 3 times daily did not reduce the incidence of diarrhoea as compared with that in calves fed only twice daily does not rule out the possibility that frequent feeding is of great value (Sheehy, 1933). It still remains probable that, if a little milk were given every hour or two, simulating the

treatment which a suckling calf receives, the incidence of diarrhoea would be greatly reduced. However, this is not practicable on a dairy farm. Feeding 3 times a day was explored because this method could have been adopted if evidence of its usefulness had been forthcoming.

Fresh or raw cow's milk reduced the incidence of diarrhoea only at a slightly significant level. This does indicate that it would be profitable to extend the use of dried milk for the rearing of calves without serious effects ensuing.

In conclusion it may be stated that in this work further evidence has been obtained to show that antibiotics have a part to play in the control of diarrhoea and the reasons for the irregular effect of the antibiotics remain to be elucidated.

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THE SPEAKERS' INTRODUCTION

The Chairman, Mr. A. L. Wilson, said that the subject of the symposium was of abiding importance and interest to everyone in the profession. The Committee had assembled a distinguished group of speakers, and the first to present a paper was Professor J. S. S. Inglis from the University of Glasgow Veterinary School.

Professor Inglis said that many hundreds of papers which had a bearing on the relationship of husbandry to calf enteritis had been written and it would be quite impossible to deal with each of those contributions in a short review. A great amount of the work in this field had been repetitive, later contributions sometimes confirming and developing previous findings but often contradicting earlier conclusions. This review selected for mention the work which he considered specially relevant and helpful in assessing the relationship of husbandry to calf enteritis.

A perusal of that literature and his own personal observations brought him to the same conclusion with regard to the aetiology as was reached by Professor Fincher of America, who said:

> "This defies accurate description, but the condition is assumed to be due to a great variety of known and, no doubt, several undiscovered factors."

One point on which the literature was agreed was that the high incidence of deaths in calves was seasonal, the winter and early spring months being the bad period. Personal observations in the Glasgow district also supported that conclusion, and in that area the position improved enormously after the cows had been at grass for a few weeks. But there were some outbreaks outwith what was normally regarded as the dangerous season of the year, notably in the autumn and even a few in the summer.

The seasonal nature of calf enteritis would indicate that factors in addition to the infective agent *per se* were important. Roy *et al.* (1955) suggested that the build-up of infection through a period of use of the calf pens might explain the seasonal incidence in the late winter, while Wood suggested that special serological types of *Escherichia coli* introduced into the calf house and becoming predominant might explain the phenomenon. That might be of importance in many cases, but why should the incidence drop within a few weeks of the cows going to grass without any special measure being taken with regard to the calf pens? That explanation was not wholly adequate, although build-up of infection during the period of intensive use might well play a part.

In this review the literature was considered under 4 headings—namely, infection, nutrition of the dam, nutrition of the calf and environmental temperatures. For more than 60 years workers had emphasised the importance of *E. coli* in calf enteritis and septicaemia, but other infective agents, including the *Salmonella* species and even viruses, had been involved in certain outbreaks. While the evidence that *E. coli* was associated with many outbreaks was strong, he had found practically no convincing experiments assessing the exact status of those organisms in initiating outbreaks. Osborne, *et al.*, writing in 1959, said:

> "While the principal genus of bacteria isolated was *Escherichia* it remains to be demonstrated that this genus represents a primary cause of calf scours."

Professor Inglis had been able to find only one reference to a group of workers causing a fatal scour in calves by feeding *E. coli*: that was Glantz *et al.* in America in 1959. It was claimed that when certain strains of *E. coli* were fed to colostrum deprived calves fatal scours developed and that one strain even caused scour when calves had suckled their dams. For that to be achieved only once after 60 years of suspecting *E. coli* was not very often. McEwan, of course, working at Moredun in 1950 had failed to cause scour in calves by feeding *E. coli* derived from dead calves to normal calves.

In view of the findings with regard to infection, one must conclude that an important aspect of husbandry was to cut infection to the minimum by constructing houses which could be properly cleaned and disinfected; they should have a proper hygienic finish, proper drainage, etc., and regular cleansing and disinfection should be carried out. Calves should be penned individually in the early stages of life and there should be solid divisions between the pens; hygienic measures should be taken with regard to feeding utensils, and adequate precautions should be adopted to prevent infection being introduced from markets, etc.

Quite a number of people had suggested that the nutrition of the pregnant dam was important in relation to calf enteritis. In that connexion the greatest agreement was in respect of the importance of vitamin A, carotine or green food. Stewart, McCallum, Sheehy, Payne, Withers, Spielman all obtained evidence suggesting that the vitamin A status was important. The findings of Stewart and McCallum (1938) were specially interesting. They found that calves born of mothers whose colostrum was low in vita-

min A were more liable to infections such as white scour and that the vitamin A content of the livers of cows slaughtered in South-west Scotland was liable to fall steeply from November to May. They knew that enteritis was at its worst towards the end of that period when vitamin A had been falling in the dams. They knew also that the vitamin A status in cows varied in different herds depending on the nature of the feeding and yields and there were hints that certain foods might exert a specific effect on vitamin A.

Professor Inglis felt the above findings with regard to the possibility of a vitamin A deficiency in the pre-partum diet playing a part in calf enteritis fitted in well with the field observations within his own experience. In a great many cases the diets encountered on farms experiencing a high death rate in calves had been apparently deficient in vitamin A potential on account of poor quality of hay or silage or straw making up the bulky part of the diet, and they had encountered such conditions both in dairy herds and in beef herds. On many occasions dairy farmers had also pointed out that scour and mortality in calves commenced after certain changes in the constitution of the concentrate ration, or even following the change on to a winter ration in October.

In many of those cases feeding a more natural type of diet adequate in green food or good quality hay had been followed by an improvement in calf health. In his opinion there was a good case for further study of the effects of pre-natal diet of the dam on enteritis and mortality in calves.

A great many research workers had studied the nutrition of the calf including its relationship to enteritis. There were numerous papers indicating the protective action of colostrum and there was agreement that the risk of enteritis and death was greatly increased when the young calf did not receive colostrum. However, the importance of feeding colostrum was universally appreciated, yet in spite of feeding it in reasonable quantities there were outbreaks of scouring and deaths.

Roy (1959) had stated that:

> "without doubt the main predisposing cause of scouring is the quality and quantity of the diet given after the colostrum-feeding period."

A number of other research workers had concluded that over-feeding could initiate scour. There would therefore appear to be widespread agreement on that point. On the other hand, there was no doubt that many cases of scouring and deaths did occur in spite of the very careful regulating of food intake. At the other extreme it had been found that feeding too little milk without giving suitable alternative foods would cause enteritis. While bad feeding of a calf might be a very important cause of calf scour in general, he was convinced beyond any doubt that that was by no means the main cause in South-west Scotland, where, no matter how carefully the feeding was regulated, the calves scoured and died around February, March and April on many farms.

The feeding of vitamin supplements to young calves had been the subject of numerous experiments. In spite of the voluminous literature with regard to that subject it was very difficult to draw any definite conclusion that feeding a vitamin supplement to the young animal made any real difference. Quite a number of workers had claimed benefits from feeding a vitamin A supplement especially to colostrum deprived calves; others found no benefit whatsoever. The same applied to other vitamins. They should keep their minds very open on that aspect. They must differentiate carefully between the effects of supplying adequate vitamins to the pregnant dam and the effects of vitamin supplementation to the new-born calf. The literature made out a much stronger case in favour of benefits accruing from supplying adequate quantities of vitamin A potential to the pregnant dam than from supplying extra vitamins to the new-born calf.

When they came to consider other aspects of feeding the calf, again the literature was full of contradictions. Lovell and Bradford Hill came to the conclusion that diluting milk did not influence calf mortality, while Sheehy (1948) found that diluting the milk with water was beneficial both in curing and in preventing calf scour. In his own experience many farmers claimed benefits from diluting milk, and of course the dilution of milk, or even feeding water for a day followed by diluted milk for the next 2 days, was widely used in treatment, but in South-west Scotland there were many cases where dilution of milk would not stop mortality. Of course, with a marginal state of health it might well have an effect and it might be that marginal condition that accounted for the discrepancies in the literature.

Three times a day feeding instead of the usual twice was claimed by Sheehy to have benefits, and again one must admit there might be advantages under marginal conditions; but they all knew that countless millions of calves were reared on twice-a-day feeding and that resorting to 3 times a day feeding would not stop many outbreaks of scour. To go to the other extreme, Blaxter found that by giving the whole of the daily food in one feed scours were induced.

There was a concensus of opinion that suckled calves did better than bucket-fed calves, but again Lovell and Bradford Hill in a limited survey found suckling did not reduce mortality compared with bucket feeding. But in another part of their survey they did find advantages in the calf obtaining colostrum by suckling the dam, so there would appear to be an advantage there. Again, it would seem that the benefits were seen where the health of the calf was marginal, as they all knew that countless numbers of calves were reared by the bucket method right from birth.

Every now and again for the last century or so someone had claimed that a nipple pail was better than bucket feeding and always after a while it was decided that there was nothing significant in it.

The prophylactic effect of including antibiotic supplements in the calf's food had been the subject of many studies, and one was left in no doubt that Aureomycin and Terramycin supplements were beneficial in preventing enteritis in many cases but they were not invariably successful. He would leave that aspect with its various implications to his colleagues.

They had seen the so-called early weaning systems developed in recent years; that was, where the calves were put wholly on to dry food at, say, 5 weeks. The indications were that they were sound and very economic provided the compound used was suitable and the calves were conditioned to those foods before being put on to them and were not specially liable to cause scour.

Withers concluded that the continued effect of adverse climatic conditions was one of the factors contributing to much of the calf mortality in the early part of the year, and a great many veterinary surgeons would agree with him. Yet they had quite a number of precise reports from America, the Continent and this country which showed that calves could be reared outside or in open sheds where the conditions were very severe without any special tendency to scour or die. Again, it must be a variation in the status of the calf itself which gave those discrepancies; some calves appeared to be able to withstand very severe conditions while others perhaps could not.

The numerous discrepancies in the research findings with regard to calf scour would appear to indicate that calf enteritis had a very complicated aetiology and was due in many cases to the interplay of a number of factors; and while they already knew a certain amount, the research workers would need to study the interplay of infection, nutrition and environmental factors before they could understand fully the exact relationship of husbandry to calf scours.

The Chairman asked Dr. H. Williams Smith to present his paper.

Dr. Williams Smith said he would like to stress that in all the studies at Stock they had been concerned with scours as it occurred under field conditions in calves which, of course, would have received colostrum. They had no experience at all of the condition that might be produced by depriving calves of colostrum. In colostrum-fed calves scours did not usually terminate in a bacteraemia, and the available evidence indicated that in those calves the scouring was associated in some manner with a proliferation of *E. coli* in the upper regions of the intestine, a region which normally contained only small numbers of

those organisms. That evidence, however, as stated in the paper, was not as yet conclusive and required further study. One reason for that was that such studies were small in number and had been concerned almost exclusively with *E. coli*, the other intestinal bacteria being largely neglected. With that in mind they had been developing reliable methods of studying quantitatively and qualitatively the bacterial flora of the gut. During that developmental period they had confined their investigations to the faecal flora and had only recently commenced studying the higher regions of the tract.

Slide: This illustrated the development of the faecal flora of healthy calves during the period when they were most susceptible to scours and indicated that *E. coli* was by no means the main bacterial constituent of the faeces. Similar studies had been carried out on calves that scoured. Quantitatively and qualitatively it was impossible to detect any significant change in the bacterial flora before, during and after the scour period. (Slide 1).

Slide: Reverting to the *E. coli* content of the faeces, Table II showed the different phage types present before, during and after the scour period. Those results together with those shown in Table I make one wonder what part *E. coli* played in scours. That *E. coli* and/or other gut bacteria were involved in field outbreaks of scours was apparent from the immunological studies of Lovell and his colleagues, and the fact that antibiotics had a favourable influence on the course of the disease—a point that had been brought out by the paper presented by Dalton and his colleagues. In fact, ecological studies had done more to stress the complexity than to elucidate the aetiology of scours. (Slide 2).

Slide: As to the effects of antibiotics on the ecology of *E. coli*, antibiotic treatment might have a terrific effect in decreasing the number of *E. coli* in the intestinal tract; and, more importantly from the clinical point of view, it supported the observations of Dalton and his colleagues in stressing the importance of giving antibiotics by mouth and not by injection. That point could not be over-emphasised. (Slide 3).

Slide: Only one or two doses of a potent antibiotic could change the *E. coli* population of the gut from a predominantly sensitive to a predominantly resistant one. (Slide 4).

The Chairman asked Mr. P. L. Ingram to present his paper.

Mr. Ingram thanked the Committee for inviting himself and Professor R. Lovell to contribute to the symposium.

He said that much of their experience with white scours in calves had come from experimental work carried out in collaboration with the National Institute for Research in Dairying at Shinfield, and under the conditions of their experiments very severe outbreaks of calf scours occurred. It was not at all uncommon for calves given colostrum, although often in small amounts, to succumb to infection even though under natural conditions the provision of adequate amounts of colostrum are usually sufficient to protect calves from death.

The type of infection seen at *post-mortem* examination was largely dependent upon whether the calf received colostrum or not. A classification of calf deaths into the septicaemic and non-septicaemic forms in relation to the feeding of colostrum was shown in Slide 1. All the figures referred to the results of *post-mortem* examinations, and it could be seen that many deaths occurred despite the feeding of colostrum. The majority of the colostrum-deprived

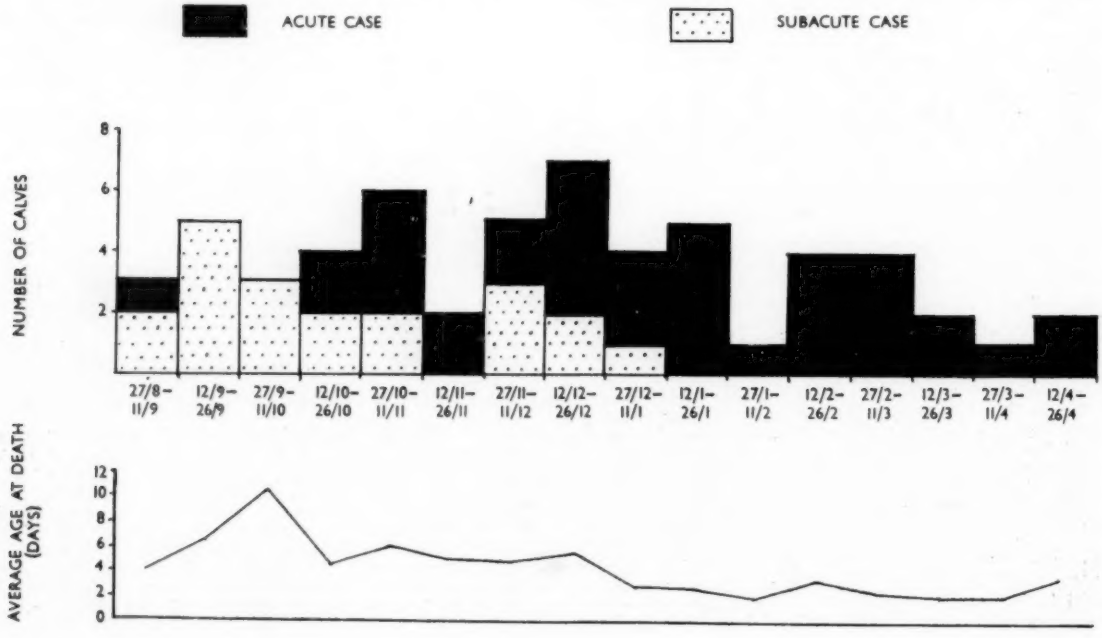
SLIDE 1

RELATIONSHIP BETWEEN THE FEEDING OF COLOSTRUM AND THE TYPE OF *E. coli* INFECTION

Diet	Number of calves	Septicaemic infection			Non-septicaemic infection
		Acute	Subacute	Total	Chronic
Deprived of colostrum	131	74	49	123	8
Colostrum-fed ...	153	15	7	22	131

SLIDE 2

DISTRIBUTION OF ACUTE AND SUBACUTE CASES IN FORTNIGHTLY PERIODS DURING THE 1950-51 SEASON



SLIDE 3
SENSITIVITY OF AN *E. coli* STRAIN PASSAGED THROUGH MICE RECEIVING STREPTOMYCIN AT THERAPEUTIC AND FEED SUPPLEMENT LEVELS

Antibiotic administered μg. per ml.	Minimum inhibitory concentration (μg per ml.) after passage number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4·58	2	2	2	5	5	5	5	5	5	5	5	5	5	5	5
9·06	2	2	2	3	3	3	3	8	8	8	8	8	11	13	13
22·90	4	6	6	6	9	9	9	9	9	—	11	11	11	11	11
45·80	2	5	10	10	10	12	12	12	16	16	16	16	16	21	21
91·60	—	6	6	18	32	125	>5,000								
136·40	—	12	26	40	>5,000										
182·20	—	10	20	48	>5,000										
Nil	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

— = Strain not recovered from faeces.

SLIDE 4
DURATION OF RESISTANCE *in vivo*. DURATION OF STREPTOMYCIN RESISTANCE IN MICE

Parent strain	Sensitivity of parent strain (μg. per ml.)	Degree of induced resistance (μg. per ml.)	Minimum inhibitory concentration (μg. per ml.) after passage number									
			1	2	3	4	5	6	7	8	9	10
A	2	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000
A	2	22	18	13	13	6	6	2				
A	2	12	8	2								
B	2	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000	>5,000
B	2	11	8	8	5	2						
B	2	5	2									

calves died with a septicaemic infection, whilst the majority of the colostrum-fed calves showed the non-septicaemic type at death. The design of their experiments was such that they were able to examine the colostrum fed to any particular calf at a later date for its antibody content, and it was interesting to note that the 22 colostrum-fed calves that died of a septicaemic infection showed strains of *E. coli* in their blood against which no antibodies could be demonstrated in the colostrum fed to those calves in their first few hours of life. These findings confirmed the conception that it was the antibody content of colostrum, qualitative and probably also quantitative, which protect the tissues of the calf from invasion by *E. coli*.

In slide 2, the pattern of calf deaths during an outbreak of colibacillosis in calves, which had been deprived of colostrum, was demonstrated. This clearly showed the relationship of the acute and subacute cases to the stage of the outbreak and indicated the appearance of subacute cases in the early stages which were gradually replaced by the acute cases. It was not yet known whether this change was associated with an increase in the virulence of the *E. coli* organisms or whether there has been a selection of the more virulent strains as a result of passage. The tracing on the lower part of this slide showed how the mean number of days of survival of the calves decreased as the outbreak progressed.

The septicaemic infections, both acute and subacute, and the non-septicaemic or chronic infections differed in the picture seen on *post-mortem* examination.

In the former type, there was ample evidence of the *ante-mortem* invasion of the tissues of the calf by *E. coli*—the organisms had been isolated from the blood of sick calves shortly before death, and there were microscopic if not macroscopic inflammatory lesions in many of the organs. Although the complete mechanism by which a septicaemia produces death is not known, massive invasion of the blood stream by bacteria is an acceptable explanation for death.

In the chronic cases, no invasion of the calf's blood stream was found at the time of death, and, at the most, *E. coli* were isolated in small numbers from the mesenteric lymph nodes; in the alimentary contents, however, very large numbers of *E. coli* were found. By some means the massive numbers of *E. coli* in the lumen of the gut produced increased peristalsis leading to diarrhoea, but once scouring occurred the loss of water, electrolytes and unabsorbed nutrients in the faeces probably played a major part in the processes leading to a fatal termination of the untreated case.

Professor Lovell said that he wanted to draw attention to a couple of points in what might be called the microbial aspect of the pathogenesis of white scours.

The first concerned the natural distribution of salmonella and of *E. coli:* this distribution forced us to take note of, the widespread occurrence of these apparently pathogenic organisms, the instability of the relationship between host and bacterium, and our ignorance of the microbial pathogenesis of these intestinal disorders. These problems were linked; we did not know in what essential respects the pathogenic strains differ from the non-pathogens—the antigenic-structural differences and the biochemical characteristics did not supply the answer. We did not know whether the pathogenic activity was determined entirely or in part by the host. If the host played the dominant part then any normal or "wild" strain of *E. coli* would be able to assume a pathogenic role.

When we knew more of these aspects then we should be able to control and treat these diseases in a logical way. It is useless to attempt the elimination or destruction of a pathogen by therapy if the so-called pathogen is one that by mutation or adaptation has recently assumed a pathogenic role.

The second point was linked with these problems for it concerns the use of antibiotics which are being used either to suppress the pathogens or to eliminate them. It has been suggested that the response of calves suffering from these disorders to streptomycin and to chlortetracycline (Aureomycin) is becoming less effective year by year. My colleague A. Bandaranayake examined the problem and as has been reported in our paper demonstrated the increasing resistance of these antibiotics of serological types of *E. coli* in mice which had received antibiotics in their drinking water. The slide exhibited (slide 3) showed the original sensitivity of a strain of *E. coli* to streptomycin to be 2 micrograms to the millilitre: this became progressively decreased up to more than 5,000 micrograms under the in-

fluence of streptomycin which had been given to mice in the drinking water in quantities which varied from 4.58 to 182.2 μg. per ml; the amounts given had been calculated according to the water consumption of the mice, and to the amounts given to domesticated animals for growth promotion and for therapy; the decrease was more rapid with large amounts of the drug.

Another slide which was exhibited (slide 4) showed the duration of the induced resistance of 2 strains of *E. coli;* after passage through normal mice it appeared as if a high level of resistance was permanent whereas low degrees of resistance were transient.

In all of the experiments the serological type of the strain had been checked at each stage and it appeared unlikely that the degrees of resistance exhibited were due to the emergence, at each stage, of strains with those specific degrees of resistance; this pointed to adaptation or mutation which had occurred *in vivo;* this had been suspected but this gives definite evidence of its occurrence.

The continued use of antibiotics may in time impair the activity of intestinal bacteria and influence nutritional efficiency—the present suggestion is of improved efficiency and of growth promotion effects—acceleration of growth may be detrimental to longevity; was this desirable in our animals? Therapy should be aimed at assisting the host—the methods employed in chemotherapy make a direct attack on the infecting organism and the duration of induced resistance was important. Short intensive treatment in animals which are ill would be less likely to affect the resistance of *E. coli* in the environment than prolonged routine prophylactic dosage.

The Chairman asked Mr. R. G. Dalton to introduce the next paper.

Mr. Dalton said that the particular study of his colleagues and himself was into the use of antibiotic preparations as a prophylactic measure in an attempt to reduce and to control the incidence of diarrhoea in calves reared at the veterinary hospital. The study could be summarised briefly by a series of slides.

The slides were then shown.

The General Discussion

Mr. J. R. Brunsdon (Glastonbury) asked whether there was evidence that some *E. coli* were toxin producers. Was it the toxin that did the damage?

Professor Lovell believed that the endotoxins of the pathogens and of the non-pathogens of *E. coli* were of the same toxicity. An attempt had been made to ascertain whether the coli was a producer of an andotoxin, but so far there was no confirmatory evidence.

Dr. S. J. Edwards (Compton) said that the paper presented by Mr. Dalton and his colleagues had given them particularly valuable information on the use of antibiotics in the treatment of calf diarrhoea. The results appeared to vary a great deal and it could not be said that the antibiotics acted uniformly on all groups of calves. This variation also had become apparent in the studies on the control of mortality and promotion of growth rate in calves which had been carried out at Compton. It had been the custom there in the last few years to purchase calves in Ayrshire for despatch to Compton and in order to prevent mortality, antibiotics had been administered to them. In one group of calves they would give a good result not only in reducing mortality but in improving the growth rate while in another the results were not so apparent. It seemed that antibiotics were most beneficial in calves subjected to some depressant factor such as a latent infection.

Referring to the general question of the development of bacterial resistance, this was of fundamental importance irrespective of whether resistant strains could be proved to be of special pathogenic significance. Dr. Williams Smith had shown first in 1956 that after the administration of antibiotics to calves there was an increase in the occurrence of resistant *E. coli* strains in the faeces. About the same time, in an experimental group of calves to which a small daily dose of chlortetracycline was administered for 14 weeks, he (the speaker) found an actual increase in the incidence of sensitive strains. It seemed that the natural faecal flora could establish itself to some extent even in the presence of small concentrations of certain antibiotics and completely after terminating their administration. There was need for further work to clarify the aspect of the use of antibiotics, since there was a widely held view that they were responsible for an increasing incidence in bacteria resistant to their action.

Mr. Dalton said he had no experience of the relative merits of antibiotics on lively and on dull calves. For the experiments in Glasgow they always selected bright calves.

Dr. Williams Smith said that he had studied pigs and chickens given antibiotics for a long time and found that resistant strains of bacteria emerged and they remained a permanent organism. He had not followed up calves for very long because rumination occurred and quite a lot of antibiotics would be destroyed in the rumen. Of course, antibiotics would not have been evolved unless bacteria were sensitive to them, and the sensitive ones were better adapted at living in the cud, but that was a general remark.

Mr. A. Mackenzie (Compton) said he believed that the problem of pig diarrhoea was quite analogous to the subject under discussion. He was rather anxious in the treatment of pig diarrhoea that the prophylactic use of antibiotics should be made as early as possible. Following some work in America he used the method of inoculation of goats with antibiotic in the hope that the antibiotic in the colostrum would provide a means whereby the bacterial population in the goat could be limited strictly at the beginning. Dr. Edwards had demonstrated the effect for the sow which was farrowing, and there was some encouragement for the treatment of piglet diarrhoea by this method.

Mr. J. B. White (Salisbury) hoped that they would not forget that husbandry was at the basis of the whole question. If an obstinate calf scour problem was encountered which resisted all others the best means of approach was to change the calf rearer. To change the method of husbandry or treatment in the middle of a rearing season in which there was trouble with scour was difficult, and if good results were not obtained the new treatment should not be considered necessarily inadequate. However, where scouring was with artificial calf rearing meals, a changeover might alter the whole position. If the new-born calves were taken to new premises the calf scouring should stop. It was a common practice. The calf scour that one experienced in the single suckled beef herd which was running out of doors under purely natural conditions was the one which gave him the biggest headache.

Professor Inglis said that it was of course necessary to assess the various factors, and Mr. White had brought the subject into perspective in relation to husbandry. The scouring might be due to the dam getting too much food and milking too well and over-feeding a calf.

Professor Lovell said that when Withers had made a survey and visited farms periodically throughout the country he made the special point that, as a rule, a girl was a far better person to look after calves than a man. With a man it was a subsidiary job, whereas a girl tended to fuss over the animals. Withers also maintained that it was not so much cold conditions as the variation in temperature and in humidity that was the factor of importance.

Dr. McIntyre said he thought, in fairness to those on the platform, that it should be said the problem was not as simple as Mr. White had inferred. Those on the platform were trying to apply their particular knowledge to a complex problem. Undoubtedly, of course, features of husbandry were of great importance.

Mr. A. M. McFerran (Scarborough) said that following the point made by Mr. White about scouring in a single suckle beef herd, he had seen a lot of scouring in a herd of this type. This would not respond to the normal treatment —antibiotics, gastric sedatives, etc. The Veterinary Investigation Service at Leeds found there was a copper deficiency, and treatment with a sheep copper (Glaxo) gave immediate results. Those calves which did not respond entirely soon improved with gastric sedatives.

The next year the cows were given a cattle copper injection, but some scouring in the new-born calves remained. This cleared up on injection with a sheep copper.

An interesting point is that only 1 case of copper deficiency had been seen in the adult cattle on this farm in the last 9 years.

Mr. A. J. Wright (Macclesfield) said he would support the

speakers who had stressed the importance of husbandry. It was his view that temperature was a most important factor. By cutting down the air space and keeping animals warm the condition would often clear up. He had seen calves which were definitely without scours put into the market and sold, and within 48 hours they had scours. The trouble was almost certainly due to chilling in the market or in transit. The whole problem had certainly increased since the modern tendency to have big concrete houses with tubular pens, where great variations in temperature could occur.

Mr. W. W. C. Gibson said it was mentioned in the paper of Professor Inglis that vitamin A was probably not of great value in the prevention of scouring. Had Professor Inglis or any of the other authors had positive experience of vitamin A deficiency in calves associated with outbreaks of white scours?

Professor Inglis said he had tried to differentiate between vitamin A supplements for the pregnant dam and getting vitamin A to the calf in preventing this trouble. He believed a case had been made out for the beneficial effect of vitamin A on the pregnant animal. He had come across many cases where there was an obvious vitamin A deficiency in the diet. There had been experiments in America in which vitamin A had been fed and the results obtained from it were good. In other experiments the administration of vitamin A had not been successful. However, different dosage rates and different methods of administration had been used.

Mr. Murphy (Dublin) said that scours occurred in the spring in the South of Ireland. When the animals went back to grass the trouble disappeared and it was felt that vitamin A deficiency might be the cause. However, when large amounts of vitamin A had been fed to cows there was no difference in mortality. Many experiments had been conducted in America and Scandinavia and central Europe where there were extreme climates and animals were housed for long periods of the year. It would be interesting to relate removal from pasture and vitamin A deficiency to the incidence of scours. Mortality was greatest between mid-March and mid-May and in Ireland that was considered to be due to build-up of infection in calf houses rather than to vitamin A deficiency. Flora did become completely resistant to antibiotics, but in the next season it was almost completely sensitive.

Mr. J. G. Watson (Nairn) said he wondered whether bloat was experienced later in life where 250 mg. of tetracycline was fed twice daily for prolonged periods to calves. One of the problems to be watched in the later life of the animal was digestive troubles.

Professor Inglis said that Mr. Murphy's remarks were most interesting. If the animals improved after being on green food for some time, it might be that factors other than those connected with vitamin A required sorting out.

Mr. D. W. Deas (Edinburgh) said that the condition was met in the South-east of Scotland. The cows were fed predominantly on grass silage. One wondered whether a particular grass silage contained the unknown factor described by Shanks in ley pastures which caused scour in calves when their dams were grazed there.

A common clinical finding of scours appeared to be the prolonged time some of the calves took to start chewing the cud. The period before adult digestion was reached was probably a susceptible time so far as the animals were concerned. Some work in New Zealand suggested that calves began to ruminate after 7 days and that, moreover, calves fed on grass and milk showed better mineral development than those fed on milk alone. It might therefore help if farmers would grow some of the good old-fashioned soft meadow hay for calves instead of using the wiry hay produced nowadays which was often unpalatable for calves.

The popular early weaning systems had not been mentioned much. It was quite successful when milk substitutes made with dried milk were incorporated but some of the so-called milk substitutes could cause considerable losses. Some of the so-called calf rearing techniques were simply agricultural gimmicks and there was no thought of the welfare of the calf associated with them.

He had recently come across an early weaning trial where the calves were treated on arrival with *E. coli* antisera and Pasteurella Vaccine, were given glucose and water for 10 days to 2 weeks, and then were put on to water and a proprietary meal crumb. The losses were high and the whole experiment was cruel and barbaric.

Professor Inglis said he had seen much of the early weaning system all over the place and it all hinged on having a suitable substitute for milk. Some of the commercial farms had done a tremendous amount of work on the subject. If a good substitute was employed it was a good and cheap method of rearing calves, but it was vital that the substitute should be suitable.

The Chairman said that the session had been most noteworthy. He wished on behalf of the meeting to thank all the authors and the others who had taken part, and he would ask the meeting to show their appreciation. (Applause.)

M.M.B. VIEWS ON THE COOK COMMITTEE REPORT

At a recent Press conference held in London, Mr. W. R. Trehane, Chairman of the Milk Marketing Board, said that any impression that the average quality of to-day's milk supply is inferior to that of the past cannot go unchallenged. "We regret," he said, "that the Report did not include evidence made available to the Committee in the latter part of its deliberations; this showed that in the first detailed survey on a large scale based on 1 in every 5 herds throughout England and Wales, butterfat averaged 3.79 per cent. and solids-not-fat 8.70 per cent. during the period 1957/59. This is the most accurate information that has ever been available, and by any standards, these figures are good."

The Board believe that before a decision on the Report is taken, there are strong grounds for giving further consideration to testing for protein rather than for s.n.f. as recommended in the Report. It is certainly of great importance in the Board's view that the proper criteria are adopted at this stage because they cannot be readily altered.

The Board are prepared to undertake a moderate and practical priced penalty scheme based on protein content. It is stressed, however, that the level at which penalties will apply will be such that the number of producers affected will be of the order that adequate technical advice and help can be given to them. The Board are also prepared to establish facilities for protein testing in connexion with the official national milk recording scheme, although such a service might not be universally available in the first instance.

BINDING "THE VETERINARY RECORD"

We are indebted to several readers who have written to us, giving costs of binding in various parts of the country. The information is as follows: Messrs. C. Fox, 72 Marylebone Lane, Wigmore Street, W.1., 25s. 6d. plus 3s. 6d. postage; Messrs. Dunn & Wilson, Bellvue Bindery, Falkirk, Stirlingshire, 24s. 9d. per volume; the Sir Robert Jones Memorial Workships, 74 Upper Parliament Street, Liverpool 8, 20s. to 23s. and postage costs; Watmoughs Limited, Idle, Bradford, 34s., which includes postage; and Langdon & Davis, Bookbinders, Maudlin Street, Bristol, 1. 20s.

Brucellosis in the Southern Sudan

BY

M. EL NASRI*

Research Division, Ministry of Animal Resources, Khartoum, Sudan

SUMMARY.—An investigation in the Upper Nile Province in Southern Sudan showed that bovine brucellosis exists in all districts of the Province and that the percentage of positive reactors is high.

The husbandry methods and other factors which appear to favour the spread of infection are discussed.

Introduction

ALTHOUGH human brucellosis was diagnosed in the Sudan as early as 1904 (Sudan Medical Service Report, 1904) animal infection was first diagnosed with certainty by Bennet (1943) in a dairy herd in Khartoum. This long lag in confirming animal infection was due to the fact that the earlier efforts of the Sudan Veterinary Service had been directed towards the control of rinderpest, contagious bovine pleuropneumonia and trypanosomiasis which caused severe losses. A non-killing disease like brucellosis seemed under those circumstances not to worry the nomadic cattle owner who did not report suspected cases to the veterinarian. As a result of several reports of abortions in Government dairies during 1953/4 and an outbreak of undulant fever among the human population, Dafaalla and Khan (1958) carried out a survey and confirmed the presence of the disease in some parts of the country.

The livestock improvement schemes planned by the Ministry of Animal Resources and the establishment of several cattle breeding centres in the country call for serious approach to the problem of brucellosis. The present survey was carried out in the Upper Nile Province in the Southern Sudan. The number of cattle in this Province is approximately 2,000,000, most of which are of the Sanga type—believed to be a cross between the hamitic long-horned ox and the lateral-horned Zebu. The climatic conditions and husbandry methods differ greatly from those in the north. The rainy season is much longer, extending from May to October in some districts: there is an abundance of tall grasses and shade; the people are predominantly nomadic and their methods of husbandry are still primitive. The presence of the disease in this Province was reported by Khalil (1953) in Malakal dairy herd.

Materials and Methods

Antigen. The antigen was prepared from a locally isolated strain of *Br. abortus* which grows well under aerobic conditions.

Serum samples. Blood samples were obtained from the jugular vein. After clotting, the serum was separated into sterile test-tubes and stored without preservative at 4° C. Sera were usually tested within 2 to 3 days after collection. Animals tested were not vaccinated.

Test. The tube agglutination test was used; serum was diluted to give final dilutions of 1:10 to 1:80. 5 per cent. saline with 0.5 per cent. phenol was used as diluent and tubes were incubated in a water bath at 37° C. for 24 hours before reading.

The standardisation of the antigen and interpretation of the results were carried out after the Weybridge method as described in the WHO Monograph No. 19 (1953).

Results

A total of 5,689 bovine sera were tested. The following Table I shows the results for each district of the Upper Nile Province.

TABLE I
RESULTS OF ANIMALS TESTED IN EACH DISTRICT

District	Number Examined	Per Cent. Positive	Per Cent. Doubtful
Fangak	1,201	16.9	4
Kodok	1,012	16.2	3
Nasir	970	18	5.5
Malakal	960	14.6	5.4
Akobo	522	17	6
Bentiu	400	17	3.5
Bor	565	13.9	4
Pibor	59	15	3

In addition to cattle, sera from 181 goats and 124 sheep from Nasir and Malakal districts were also examined. The percentage of positive reactors for goats was 6.6 and for sheep 3.0.

Discussion

These results show that bovine brucellosis is prevalent throughout the Province and that the rate of infection is rather high. However, it is not surprising to find such a percentage of positive reactors in view of the climatic conditions and the primitive methods of husbandry practised in the south which would tend to facilitate the spread of infection. During the dry season cattle spend the night in the open around smoke fires built to drive away biting insects and which consist of burning dried cow dung. Thus a foul atmosphere of dust, dung particles and smoke is created in which cattle are tethered close to one another as an attempt to avoid the risk of building too many fires. In many districts cattle are driven to the "toich" to get green grass and water. The "toich" consists of a dense growth of tall grass with plenty of water left by the receding river. This movement to and from the "toich" grazing sometimes leads to the concentration of thousands of cattle in certain areas along the route.

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* Present address: Faculty of Veterinary Science, University of Khartoum

An Unusual Case of Caesarean Section in an Old Shorthorn Cow

BY

T. G. YARROW and R. BRADLEY

Winchester, Hants.

Subject. A 17-year-old Shorthorn cow pregnant for the thirteenth time and due to calve in 3 weeks time. This cow had given birth to about 6 sets of twins yet had only produced 1 heifer calf from the previous pregnancies. In view of this cow's regular breeding ability, good health and good milking qualities, the owner was most anxious to obtain a second heifer calf from her.

Although successful caesarean section is a well recognised operation in the bovine animal, references have in the past been made to this operation after the dam has been stunned. This technique has also been used to save a valuable foal at the mare's expense when delivery *per vaginam* is not possible. The possibility and usefulness of the technique is described in this recent case.

History. The cow was presented for examination in the first instance because she had been recumbent for one week, although otherwise she was in perfect health. No obvious reasons for the recumbency could be found. She was treated with a proprietary brand of magnesium, phosphorus, calcium and dextrose intravenously and calcium borogluconate subcutaneously but she resisted all efforts to make her rise. A vaginal examination revealed a closed cervix with intact mucous seal, while a rectal examination revealed a live calf in anterior presentation. Judging by the size of the cannon bone and the foot, the calf was a small one and therefore a twin pregnancy was suspected. It was decided to allow the cow to calve on her own or else to destroy her if she suffered pain.

Six days later the cow developed a typical "milk fever" syndrome, was treated and recovered, though she still made no attempt to get up. The cervix was in the same condition as before, so in an effort to hasten the onset of calving, 15 mg. stilboestrol dipropionate was injected intramuscularly.

Some 36 hours later the owner telephoned to say that the cow appeared to be about to die. This was indeed the case; the cow was prostrate and in pain and her temperature had dropped to 98° F. The cervix was still closed but a rectal examination revealed a live calf. It was decided to stun the cow and to remove the calf by a caesarean section.

Operation. The cow's front and back legs were tied to suitable fixtures to avoid kicking when the abdomen was opened. One of us stunned the cow using a captive bolt pistol and then the throat was cut. Some 16 oz. of blood were collected in a bottle containing sodium citrate solution. A large incision was now made in the left flank, through skin, muscle, peritoneum. The uterus was brought outside the skin wound and incised, the foetal membranes were cut and the cow was delivered of a single, normal size, live heifer calf. In order to compensate for loss of colostrum the calf was injected with the blood previously collected from the dam and was then

(*Concluded at the foot of col.* 1, *page* 1202)

Brucellosis in the Southern Sudan.—*Concluded.*

During the rainy season when cattle owners have returned to their villages inland the picture is different. All cattle graze together by day in the surrounding area, but during the night each owner houses his animals separately in mud huts with thatch roofs known as "luaks" to protect them from rains and the wet ground. Smoke fires are also used inside these luaks which are devoid of ventilation and the conditions are those of over-crowding. Since *Brucella* infection can be transmitted by contact it becomes obvious that such methods of husbandry play a big part in the spread of infection. Moreover these conditions are believed to favour the spread of contagious bovine pleuropneumonia and tuberculosis.

The nomadic life of the cattle owner, together with his almost sacred association with the cow and his traditional objection to parting with any of his animals except under certain compelling circumstances, make control measures difficult. The owner's satisfaction with an outwardly normal animal and his desire to have one beast more in his herd, coupled with the tradition of presenting cattle for marriage, will also continue to constitute a strong challenge to improvement. But it may still be possible to attempt control and eradication on an area basis, especially when we take into consideration the fact that each tribe adheres to its own district, and that cattle movement is nearly always within the district.

Acknowledgment.—My thanks are due to Dr. I. M. Khalil, Director, Ministry of Animal Resources, for his permission to publish this article, and I am indebted to Dr. E. A. Karib, Assistant Director (Research), for encouragement and criticism. I wish to thank Hassan Eff. El Faki, senior laboratory assistant, for his help.

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The Development in the Dog of Naturally Acquired Antibody to Canine Virus Hepatitis in Relation to Age

BY

R. E. ABLETT

AND

L. A. BAKER

Glaxo Laboratories Ltd., Greenford, Middlesex

Introduction

CANINE virus hepatitis has for many years been known to occur in this country. Pay (1949) produced evidence of cases occurring in the period 1927-34. Since Rubarth (1947) first described the disease, information has been published on the viability of canine hepatitis virus outside the body (Larin (1951); Fastier (1958); Larin (1959)). It has also been demonstrated that the virus can, after inoculation, be liberated in the urine of the dog for up to 161 days (Poppensiek & Baker, 1951). Larin (1958) in his epidemiological studies suggested that most infections were either clinically inapparent or mild. He also produced evidence suggesting that "healthy" carriers may be implicated in the spread of the infection. The epidemic nature of the disease was discussed.

All of this information would suggest a high incidence of the disease in this country. In an attempt to check this we began early in 1959 examinations of neutralising antibody in the sera of dogs from various parts of England.

Materials and Methods

Serum neutralising antibody test. The test was carried out in test-tube preparations of monolayers from canine renal epithelium with 500-1000 T.C.I.D. 50 of virus in 0.1 ml. Serum dilutions were prepared in physiological saline solution. The mixtures of serum and virus were incubated at 37° C. in a water bath for 1 hour and then added to the tissue culture system, four tubes for each dilution, and incubated at 37° C. on roller drums. The results were read at 5 to 7 days, by which time complete degeneration had occurred in the control tubes inoculated with virus alone.

Results

Practising veterinary surgeons sent us blood samples from randomly chosen dogs of various ages, and the results are tabulated below. Piercy and Sellers (1960) reported that some dogs inoculated with an attenuated canine hepatitis virus used in the preparation of live canine hepatitis vaccine excreted this attenuated virus. This was demonstrated by in-contact dogs' development of antibodies. Because of this the figures quoted below relate to our findings before the marketing in this country of live attenuated hepatitis vaccines.

RESULTS OF SERUM NEUTRALISING ANTIBODY EXAMINATIONS

Age	Total number of dogs examined	Number of dogs showing no antibodies	Number of dogs showing positive antibodies	Percentage of dogs showing positive antibodies
6 weeks to 3 months	15	13	2	13·3
3 months to 6 months	22	5	17	77·3
6 months to 9 months	23	4	19	82·6
Over 9 months	164	29	135	82·3

Results from puppies under 6 weeks of age are not included in order to eliminate those showing antibodies derived from the colostrum of the dam.

The figures in the "over 9 months" group do not include a series of bitches from breeding kennels; the results from these are reported by Ablett and Baker (1960).

The results suggest that most puppies come into contact with the virus during the second trimester of life.

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An Unusual Case of Caesarean Section in an Old Shorthorn Cow.—*Concluded.*

reared on another recently-calved cow. Six months later the calf was doing well.

Discussion. Although this technique may be archaic, it may, occasionally, as in this case be of value. There appears to be some time lag between the stunning of the dam and the death of the foetus; in this case some 30 seconds elapsed before the calf was delivered, yet it appeared to suffer no ill effects from its ordeal.

The after treatment of the calf was regarded as most important, particularly by the drying of the coat, providing warm, dry shelter (possibly with infra red heating) and rearing on a recently-calved cow. The blood injection seems to be of great value in any debilitated calf, and in this case, contributed antibodies which in some measure made up for the absence of the dam's colostrum.

Current Literature

BOOK REVIEWS

British Small Animal Veterinary Association Congress Proceedings, 1959. BRUCE V. JONES (Ed.). Pergamon Press (1960). 55s.

This volume contains the report of the proceedings of the second Annual Congress of the B.S.A.V.A.

In its presentation it is more ambitious than the first report and it is bound in cloth covers. The Congress programme on this occasion is again generally of considerable interest and covers a wide field. Inevitably the standard varies from paper to paper, and the discussions perhaps even more so. Discussions following some papers are limited to question and answer, which is obviously a loss on those subjects where there can legitimately be fairly wide divergence of opinion; this does not apply, however, to the discussions following the main symposia, which range freely and are reported in full.

Taking the contents in order, the introductory chapter consists of the Presidential Address. There is then a paper on "The Treatment of Anal Conditions," in which the author describes cases from his own experience. He gives a fairly wide selection, but has no new ideas to offer.

"The Rôle of the Veterinary Surgeon in Civil Defence" is discussed, the paper consisting of a description in simple terms of the probable effects of a 10-megaton Hydrogen Bomb and a discussion of the possible rôle of the veterinary surgeon in salvage of food supplies, conservation, and subsequent slaughter for food, of the less severely affected animals and preservation where possible, and the prevention of outbreaks of infectious disease among surviving herds.

A paper on "Radiotherapy in Small-animal Practice" gives a clear, concise account of the principles underlying the use of X-rays therapeutically and their application in veterinary practice. The author has had an unusual opportunity to carry out this work in private practice, which he has evidently grasped to the full, and in so doing has given us a paper of great interest as a result of his initiative.

The paper on "Vitamin E Therapy" is a simple clinical account of the use of this agent in small-animal practice. Not all will agree with the author's conclusions although most will feel that there is room for further trial. The author may be criticised for failing to emphasise the possibility of natural recovery in some of his cases; for example, a dachshund is described as showing an immediate improvement in a case of paraplegia when put onto vitamin E after two weeks of other treatment. This degree of delay in natural recovery is sufficiently common in this condition to question whether or not the vitamin E given subsequently was, in fact, responsible.

Its effect on oedematous tissue surrounding some tumours is of great interest and it may be of considerable value in reducing a tumour mass to an operable state. The logic behind the use of the vitamin in skin cases and ulcers is more difficult to follow, but the possibility of improvement in local circulation cannot be discounted.

Statements that vitamin E may act as a "normaliser" of the endocrine system, however, leave the readers with the impression that the author is inclined to be guilty of woolly thinking and a tendency to overstate his case which is a pity, as the subject seems worthy of more critical assessment than it has been given here.

There follows a symposium on "Intervertebral Disc Protrusion" in which the first author gives a fairly detailed description of the clinical symptoms seen in cases classified according to the level of the protrusion. He discusses methods of diagnosis and the value, advantages, and disadvantages of both straight X-ray and myelography.

This paper is followed by one discussing prognosis and treatment, the prognosis being based on the assessment of the extent of actual spinal cord damage; and, finally, there is a paper on the anatomical and pathological features.

The whole symposium forms a useful reference for the student and the clinician.

Turning from clinical papers to the organisation of a practice, we next have a reasoned argument for concerted action in the planning, costing, and general organisation of veterinary practice in this country, followed by a verbatim report of the discussion.

"The Clinical Examination of the Nervous System of the Dog" is next discussed. There is a systematic description of clinical manifestations that accompany damage to the various parts of the nervous system, followed by a description of the order and technique of examination.

This type of paper is of the greatest possible value to the clinician and represents work on a subject that has been for too long neglected within the profession.

A discussion on the "Activities of the Kennel Club" by its secretary is of general news value to the veterinary surgeon dealing with pedigree dogs, and there can be no disputing the fact that mutual understanding between that body and the profession can be of great value to both.

We are next given a brief paper on "The Diagnosis and Treatment of Oesophageal Conditions in the Dog," which is followed, and to some extent amplified, by a good discussion.

A paper on "Calcium and Iodine Deficiency in Meat Fed Cats with Reference to *Osteogenesis imperfecta*" gives us an excellent summary of the author's original work on this subject. It is well documented and throws light on what was previously thought to be an inherited condition.

We then come to a "Symposium on Unusual Patients." With the continued interest in small pets of all kinds evinced by the public to-day, a great deal of what might be termed basic information on their management is of value to the veterinary surgeon. Some of this, a little light relief, and a good deal of general interest is provided here.

We are first given a very brief account of the

anatomy and some notes on the management of tortoises and terrapins; then some information on the management and diseases of hamsters and guinea-pigs, mainly derived from work with these species as laboratory animals, but nevertheless referable to conditions met with in practice.

The first contribution on chinchilla is entirely of general interest and provides the light relief from the scientific and clinical side of the programme.

To follow this we are presented with the owner's viewpoint and a fair challenge to our ability to help. Then we get down to our own side of the situation with two papers, one on the "Pathology of Chinchillas and Monkeys" and the other on the "Clinical Approach." Between them these two give us invaluable information of a practical nature, and it is evident in the discussion which follows that the chinchilla, at any rate, is now being widely met with in practices up and down the country.

In his "Clinical Observations on the Use and Misuse of Sex Hormones," the next author states that the paper should be considered mainly as an opening for discussion; even so, the reader feels that his observations suffer from too much brevity and an over-simplification of the issues involved. His terminology is at times rather vague, for example, "eczema of spayed bitches," without any description of lesions; and the statement that stilboestrol may be used to produce "oestrus"—surely he means merely symptoms of oestrus.

In advocating the use of stilboestrol in the male for anal adenoma where surgery be contra-indicated, no mention is made of toxicity or undesirable side effects.

The abridged discussion with which we are supplied does little to remedy these defects, which may be those of an over-crowded programme rather than of the author's experience.

The following chapters report a symposium on "Current Thought on Major Infectious Diseases of the Dog." The first paper on "The Nature of the Distemper Virus Complex" is clear, thoughtful, and well documented, and of distinct value at this time.

That which follows on "Toxoplasmosis and its Relationship to Canine Distemper" is at present of more academic than immediate clinical interest, although its import is well summed up in the author's words: "while the clinical importance of toxoplasmosis ought not to be over-estimated veterinarians should be aware of the condition, because of its significance in human as well as veterinary medicine." This paper includes a brief note on other mixed infections such as leptospirosis and infectious canine hepatitis.

Finally, the symposium deals with "The Egg-Adapted Virus in Therapy and Prophylaxis." This paper gives a clinician's viewpoint and by its very nature will, in many places, be open to differences of opinion.

The subsequent discussion is fairly wide and is well worth reading critically.

The final paper describes the "Analysis of the Survey on Fees." Actual figures of charges have here been left out of the printed paper, but there is much of interest in the comparison between areas and in the suggested points system on which to base fees. This paper may be regarded as an interim report, the final one to be correlated with the figures obtained by the economic survey undertaken by the S.V.P.S.

The volume closes with the report of the second Annual General Meeting of the B.S.A.V.A.

To sum up, the volume provides a great variety of information and a valuable reference for the small-animal clinician, leaving as the chief point of criticism the feeling that it might have been an advantage to have dealt with fewer subjects more thoroughly.

Once again the B.S.A.V.A. is to be congratulated on a very successful Congress.

Abriss der Klinik der Hundekrankheiten. By HORST-JOACHIM CHRISTOPH. Gustav Fischer, Jena (1960). 45.90 DM.

This "Outline of Clinical Canine Medicine" is written by the Professor of Small-animal and Experimental Surgery and Director of the Small-animal Clinic in the Karl Marx University in Leipzig. It is not intended to be a comprehensive work but is essentially a book in which the author describes mainly the conditions he has himself encountered. It is intended for students and practitioners and consists of 2 main parts: an introductory section of some 70 pages which deals with clinical examination, restraint, administration of medicaments and anaesthetics, the use of plaster, and euthanasia, and a second part, comprising some 350 pages, dealing with selected diseases system by system starting with the skin and ending with the endocrine organs, and also including chapters on some important infectious diseases and on poisoning.

It is essentially a practical book, describing how conditions are dealt with by the author and his colleagues in Leipzig. It includes a section on rabies in which the incubation period is given as 2 to 8 weeks and it is stated that not all rabid dogs die from the disease. Certain other conditions are also not applicable to this country, including such operations as ear cropping and cutting the tail tendons to make curled tails straight. Surgical conditions are naturally dealt with more fully since this is the author's own field. Eye surgery is dealt with in some detail and there are many useful diagrams to illustrate surgical procedures such as extraction of the lens. A very large number of excellent radiographs illustrate most sections of the book.

A wide variety of medicaments are mentioned in the text, some of them truly surprising, such as birch leaf tea for dogs with phosphatic urinary calculi, oak bark tea for gastritis, and over 20 different prescriptions for eczema.

The excellent illustrations, some of them coloured, make this book well worth looking at, quite apart from its text. Small-animal practitioners are bound to find something to interest them within its pages. Its main value is local, as is reflected by the list of drugs at the end—most of them have only their German trade names and there is no clue as to what their active ingredients are.

News and Comment

SWINE FEVER VACCINATION SCHEMES

Further to the paragraph published under this heading in THE VETERINARY RECORD of November 26th, B.V.A. divisions, veterinary clubs, or other bodies of veterinary surgeons who intend to take part in a certified crystal violet vaccination scheme are invited to communicate with the General Secretary of the B.V.A. to obtain fuller information.

B.V.A. EVIDENCE TO OFFICIAL COMMITTEES

Government Committee of Enquiry into Fowl Pest

By request the B.V.A. presented a Memorandum to this Committee, commenting upon the present slaughter policy for control of fowl pest, and making observation on methods of control. Dr. W. R. Wooldridge, as chairman of the B.V.A. sub-committee on this subject, was spokesman for a delegation which gave oral evidence to the Committee on December 1st. His colleagues on that occasion were the President, the General Secretary, Dr. R. F. Gordon, Dr. W. P. Blount, and Mr. W. E. Lancaster.

Food Hygiene Codes of Practice, Poultry Dressing and Packing

Representatives of the B.V.A. in the persons of Mr. G. Atkinson, Mr. H. E. Bywater and the General Secretary attended the Ministry of Health on December 14th, to discuss this subject. Previously a B.V.A. Memorandum had been compiled and put forward for consideration.

FOOT-AND-MOUTH DISEASE

Now that the danger of further widespread outbreaks of foot-and-mouth disease in the present series appears to have passed, the Controlled Area restrictions, which had covered much of England for the previous 2 weeks, were withdrawn as from midnight, on December 10th.

Normal Infected Area restrictions remain in force in the neighbourhood of all confirmed outbreaks of disease.

THE ROYAL COLLEGE OF VETERINARY SURGEONS

Temporary Building

The present office of the College at Red Lion Square will be closed at 5 p.m. on the evening of Thursday, December 29th, and will re-open at the new temporary address—College House, Wright's Lane, Kensington, W.8.—on Monday, January 2nd, 1961, at 9.30 a.m.

It is asked that enquiries and correspondence may be kept to the minimum during the week immediately before and after the move.

Wright's Lane runs south from Kensington High Street along the side of Messrs. Pontings. College House is a modern office block on the left towards the bottom of Wright's Lane, when approaching from Kensington High Street. The College accommodation will be on the first floor. Kensington High Street Station (District and Circle lines) is immediately adjacent to the temporary College building.

REFRESHER COURSES IN MEAT INSPECTION

Secretaries of Divisions have been informed that refresher courses in the practice of meat inspection can be arranged at several centres in Great Britain provided there is a sufficient number of applicants. These courses are designed for practising veterinary surgeons and will take the form of talks either combined with or followed by practical demonstrations conducted in the abattoir by a veterinary surgeon engaged in whole time meat inspection. The instruction will be spread over a period of about 16 hours. The times and fees for the course will be arranged by the lecturer in consultation with the local Division of the B.V.A.

A panel has been formed of veterinary meat inspectors who have kindly expressed their willingness to collaborate in every possible way; in some cases these panelists are prepared to travel away from their homes to meet local requirements. Members who wish to take advantage of these arrangements should communicate, without delay, with the honorary secretary of their Division.

LIVERPOOL VETERINARY INVESTIGATION CENTRE

We are advised from the Ministry of Agriculture, Fisheries and Food, that during the period December 24th to January 7th the Liverpool Veterinary Investigation Centre will be closed, when the staff will be involved in a move to new premises. The new address will then be:—

Ministry of Agriculture, Fisheries & Food,
Veterinary Investigation Centre,
Vine Street,
Liverpool, 7.

There will also be a change of telephone number to ROYal 5848/9.

CLASSIFIED ADVERTISEMENTS

Will readers kindly note that having regard to the Christmas vacation, classified advertisements intended for our December 31st issue must be received by Wednesday, December 21st.

HISTORIC OFFICE FOR MAJOR WORTLEY

Major Walter Hunt Wortley, of Bungay, Suffolk, who has been a veterinary surgeon there for 40 years, has been installed as Town Reeve of Bungay, the only such office in the country. It is more than a thousand years old, dating without a break from Saxon times. In bygone centuries the holder was something of a dictator, and a link with that authority still survives in that the outgoing Town Reeve makes the nomination at the annual Town Meeting on the first Tuesday in December and it is accepted without any question of vote. The choice is made from an august body of elder citizens known as Feoffees.

Although the Town Reeve is only the head of a charity he is the citizen with the maior standing in the place and enjoys more prestige than the chairman of the Urban District Council. The income administered by the Town Trust, of which he is the head, comes from town lands in the district and is spent on amenities for Bungay which cannot be provided out of the rates. The welfare of the old folk is of special consideration.

The deputy Town Reeve invested Major Wortley with the gown, hat and chain of office, which he wore on the following evening when he appeared on B.B.C. television.

CHAROLLAIS CATTLE

In reply to questions in the House last week about the Terrington Report, the Minister of Agriculture said:—

"The Secretary of State for Scotland and I have carefully considered the Committee's report and have taken into account the views of all the organisations concerned. We agree with the Committee that there is a good case for a trial of some Charollais bulls imported under the strictest veterinary control.

"The Secretary of State and I are satisfied from the expert advice available to us that with the extremely strict precautions which would be taken, there could be no risk of introducing disease into this country. We have however to take into account the possible effect upon the international livestock trade if the proposed importation of Charollais from France were proceeded with at this juncture.

"While, therefore, we accept in principle the desirability of trying the Charollais experiment at a convenient opportunity, we are not proposing to proceed with the importation for the time being."

R.V.C. ASSOCIATION ANNUAL GENERAL MEETING

The fifth annual general meeting of the Association was held at the Royal Veterinary College on November 11th. It was the day of the Commemoration Ball and also the Association's birthday.

The President gave a good account of the activities of the Association. Although it was not old in years it was vigorous in body and spirits. Five happy annual reunion dinner meetings had been held at the College, and there were nearly 300 members. The financial state was sound and a good start had been made with a provident fund which could be used to help any "Old Londoner" who might be in need.

It was not necessary to elect officers and council at this A.G.M. as those had been elected to serve for a period of three years. Having considered the state of membership and the financial affairs the main business of the meeting was to make the preliminary arrangements for the annual dinner in 1961.

It was reported that a number of members had expressed a wish to hold a dinner at Oxford during the 1961 B.V.A. Congress week. A small ways and means committee was appointed to explore this matter. If the findings of this committee are favourable it was agreed that the project be implemented.

A discussion took place as to whether the annual dinner should be held, in subsequent years, at the Congress. The President said that as the heart of the R.V.C. Association was in Camden Town, the dinner should be held at the School, or if attendance figures should grow beyond the limits of that institution, at some other place in London. He was in favour of holding a luncheon or dinner at the B.V.A. Congress, but this should be an extra.

PERSONAL

Miss J. O. Joshua was the guest in the Woman's Hour programme of the B.B.C. last Monday. The main theme of her talk was the way in which new pets, given as Christmas presents, should be looked after.

Birth

HALHEAD.—On November 27th, 1960, to Susan, wife of Anthony Halhead, B.V.SC., M.R.C.V.S., of Whychurch House, Malmesbury, a daughter, Sarah Louise, a sister for James and Richard.

Engagements

MILLER—HATTERSLEY.—The engagement is announced between John Keith Miller, B.V.SC., M.R.C.V.S., younger son of Mr. S. Miller and the late Mrs. Miller, of Formby, Lancashire, and Jean Hattersley, L.R.A.M., only daughter of Mr. and Mrs. W. Hattersley, of Sheffield.

WHITEFORD—PAGE.—The engagement is announced between Robert Brian Whiteford, M.A., VET.M.B., M.R.C.V.S., twin son of Dr. and Mrs. J. D. Whiteford, of Walthamstow, London, and Rosemary Lucy Page, elder daughter of Mr. and Mrs. R. W. Page, of Glazeley Manor, Bridgnorth, Shropshire.

R.C.V.S OBITUARY

We record with regret the death of the following members of the profession:—

FRASER, Hugh, of 12 Abbey Mead, Tavistock, Devon. Graduated at the Royal (Dick) Veterinary College, Edinburgh, December 17th, 1910. Died November 28th, 1960.

GOLLEDGE, Lionel St. Bel, The Green, Nether Compton, Sherborne, Dorset. Graduated London, December 11th, 1919. Died December 9th, 1960, age 66 years.

KING, Nevill Salusbury, of Whyteleafe, Llanbedrog, Pwllheli, North Wales. Graduated London, July 13th, 1921; died December 1st, 1960, aged 61 years.

Mr. King has expressed the wish that donations in lieu of flowers should be sent to the Victoria Veterinary Benevolent Fund.

MCDONOGH, Matthew, of Ennistymon, Co. Clare, Eire. Graduated Dublin, July 24th, 1924; died suddenly December 3rd, 1960.

MR. MATTHEW McDONOGH

G. C. writes:—

"Matt" McDonogh was an exceptionally fine man and was much loved by his countless friends both inside and outside the profession. He had been in Co. Clare for many years and had developed a very extensive general practice.

It was while he was doing his work late on a Saturday night that he became ill, collapsed and died in a short time.

He will be sadly missed, and the deepest sympathy of his friends is extended to his wife and to their five young children.

UNIVERSITY NEWS

Edinburgh

The undermentioned candidates have passed the final professional examination for the degree of Bachelor of Veterinary Medicine and Surgery:—

Calvert, David John; Gardner, Edward Albert; Goodman, Alan Philip; Harrison, Richard Dex; Lowe, William Alistair; McIlveen, Samuel Walter Dermot; Radley, David Ewart; Searles, Patricia Anne; Seckington, Ian Michael; and Wilkinson, Ian Speed.

THE ASSOCIATION OF VETERINARY STUDENTS

The Annual Conference of the Association will be held in New Brighton, Wallasey, from January 20th to 22nd, 1961. The Liverpool University Veterinary Society will be acting as host. The programme will be as follows:—

Friday, January 20th.

10 a.m. Official opening in Wallasey Town Hall by Mr. G. N. Gould, senior Vice-President of the Royal College of Veterinary Surgeons.

11 a.m. Symposium and discussion—"The Veterinary Profession, Past, Present and Future." Speakers: Mr. J. W. Barber-Lomax, Mr. L. G. Anderson, Professor J. G. Wright.

2 p.m. Commercial visits, films and sports.

8 p.m. Dance in the Students' Union, Liverpool.

Saturday, January 21st.

Visit to the University of Liverpool Veterinary Field Station, Leahurst. Closed-circuit T.V. surgery demonstration. Tour of the new veterinary building.

Sunday, January 22nd.

11 a.m. A.G.M. in Wallasey Town Hall.

1.30 p.m. Visits to Chester Zoo and Great House Experimental Husbandry Farm, Rossendale.

COMING EVENTS

January

5th (Thurs.). CENTRAL VETERINARY SOCIETY. Meeting at the Royal Veterinary College, Camden Town, N.W.1., 6 p.m.

20th, 21st and 22nd (Fri., Sat., and Sun.). Annual Conference of the Association of Veterinary Students in New Brighton, Wallasey.

February

9th (Thurs.). Annual Ball of the Royal (Dick) School of Veterinary Studies in the Assembly Rooms, George Street, Edinburgh, 9 p.m.

B.V.A. COMMITTEE & COUNCIL MEETINGS

Tuesday, January 17th, at 7, Mansfield Street

5 p.m. Finance Sub-committee.

Wednesday, January 18th, at 7, Mansfield Street

10.30 a.m. Farm Livestock Committee.

12 noon. Home Appointments Committee.

2.15 p.m. Small Animals Committee.

4 p.m. Parliamentary and Public Relations Committee.

Thursday, January 19th, at 7, Mansfield Street

10.30 a.m. Veterinary State Medicine Committee.

2.15 p.m. General Purposes and Finance Committee.

Friday, January 20th

10.15 a.m. Council Meeting, Connaught Rooms, Gt. Queen Street, London, W.C.2.

ADDRESSES OF DISEASE INFECTED PREMISES

The list given below indicates, first the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax

Aberdeen. Shiel, Leochel Cushnie, Alford (Dec. 5).

Cardigan. Blaennoffnant, Brynnoffnant, Llanddysaul (Dec. 12).

Durham. Grange Farm, Whorlton, Barnard Castle (Dec. 5).

Leics. Grants Farm, Church Langton, Market Harborough (Dec. 7).

Norfolk. Brick Kiln Farm, Saham Toney, Thetford (Dec. 12).

Northumberland. Rothill, Whittingham, Alnwick (Dec. 12).

Staffs. Mill Meece Farm, Eccleshall (Dec. 12).

Sussex. Mount Pleasant Farm, Flimwell, Wadhurst (Dec. 7.)

Foot-and-Mouth Disease

Aberdeen. North Main of Barra, Old Meldrum (Dec. 6); Tweedale Farm, Keithall; Boat of Hatton, Fintry; Howe of Tarty, Ellon (Dec. 8); North Collielaw, Peterhead; Daneston Farm, Woodside (Dec. 9).

Lincs. Cleetham Hall, Kirton Lindsey, Gainsborough (Dec. 10).

Northumberland. Whinneyhall Farm, Stannington, Morpeth (Dec. 8).

Notts. Mill Farm, Oxton, Newark (Dec. 6); Newlands Farm, Forest Town, Mansfield; Crown Farm, Eakring Road, Mansfield (Dec. 12).

Orkney. Valdigar, Tankerness, Kirkwall (Dec. 6).

Salop. Newhouse Farm, Hutton Hinstock, Market Drayton (Dec. 8).

Fowl Pest

Beds. Polhill Allotments, Bedford (Dec. 11).

Dorset. Woodclose Poultry Farm, Stourton Caundle, Sturminster, Newton (Dec. 12).

Essex. Sumptners Farm, East Hanningfield, Chelmsford (Dec. 5); Kiln Farm, Mount Nessing Road, Blackmore, Ingatestone (Dec. 6); The Edwins, Church Lane, Crayshill, Billericay (Dec. 7); Broad Street, Green, Maldon; Watici, Southlands Road, Crayshill, Billericay; Whitebridge Farm, Grayshill, Billericay; The Briars, Castelton Road, Downham, Billericay (Dec. 8); Red Rose Farm, Blackmore, Ingatestone (Dec. 9); Lodge Road, Poultry Farm, Bicknacre, Chelmsford (Dec. 11); Pilgrims Farm, Little Baddow, Chelmsford; 34 Southend Street, Wickford; Westbury Poultry Farm, Downham, Billericay; Sailesfirth Farm, East Hanningfield, Chelmsford (Dec. 12).

Herts. York House Farm, Aspenden, Buntingford (Dec. 5).

Hunts. 14 Princes Street, Ramsey (Dec. 9).

Norfolk. Streamlet, Starston, Harleston; Slings Farm, North Green, Pulham St. Mary, Diss; St. Whews Farm, Caston, Attleborough; Boundary Farm, Winfarthing, Diss; Tithe Farm, Fressingfield, Diss; Tarr Lane, Poringland, Norwich; Moat Farm, Kirstead, Brooke, Norwich; North Winterton Poultry Site, The Highlands, Winterton, Great Yarmouth; Hill House Farm, Hebendenham, Bungay (Dec. 5); Prospect Farm, Shelton Common, Shelton, Harleston; Stolleries Farm, Diss; South Winterton Poultry Site, Highlands, Winterton, Great Yarmouth; Hawthorns Farm, Alburgh, Harleston; Mere Cottage, Seething, Norwich; Elm Tree Farm, North Green, Pulham St. Mary, Diss; Ash Tree Farm, North Green, Pulham St. Mary, Diss; Common Farm, East Tuddenham, Dereham; Dam Green, Kenninghall, Norwich; Quaker House, Mattishall, Dereham; Holme Farm, Suton, Wymondham; New House Farm, Brooke, Norwich; Home Farm, Whinsburgh, Dereham; Manson Green Farm, Hingham; Rear of 523, Earlham Road, Norwich (Dec. 6); Fir Tree Farm, Weybread, Diss; Old Rectory, Caston, Attleborough; High Barn Farm, Winterton, Great Yarmouth; Tongate Farm, Scoulton, Norwich; Belgravia, Stoke Road, Poringland, Norwich; The Beeches, Seething, Norwich; Post Office, Freethorpe, Norwich; Weybread House, Harleston; Whitehouse Farm, Hockering, East Dereham (Dec. 7); Lyng House Farm, Lyng, Norwich; Heath Farm, Rollesby, Great Yarmouth; Mivelle Farm,

Forncett St. Peter, Norwich; The Grange, Rollesby, Great Yarmouth; The Nest, Aylmerton, Norwich; High Bread Farm, Fir Cover Road, Taverham, Norwich; Mill Farm, Needham, Harleston; Vale Farm, Hockering, Dereham; The Little Strip, Shelton, Long Stratton; Street Farm, Hardwick, Norwich; 19 Cawston Road, Reepham, Norwich; Hill Farm, Hackford, Norwich; Stallard Farm, Great Ellingham, Attleborough; The First, Reepham, Norwich; Weston Longville Airfield, Weston Longville, Norwich (Dec. 8); Junction Farm, Ingham, Norwich; Scoulton Road, Rocklands, Attleborough; The Bell Inn, Marlingford, Norwich; Hall Farm, Horsey, Great Yarmouth; Adelaide House, Saxlingham; Witten Green Stores, Reedham, Norwich; Beaconsfield Farm, Ingham Road, Hickling, Norwich; Grange Farm, Hempnall, Norwich (Dec. 9); Hill Farm, Saxlingham, Norwich; The Green, Freethorpe, Norwich; Rose Bank, Norwich Road, Yaxham, Dereham; Mill Farm, Ingham, Norwich; Hill Farm, Rollesby, Great Yarmouth (Dec. 10); Croft Road, Winterton-on-Sea, Great Yarmouth; Boundary House, Yaxham, Dereham; Yaxham Road, Mattishall, Dereham; Rookery Farm, Thuxton, Dereham; Low Farm, Sisland, Loddon, Norwich; Four Sticks, Hainford, Norwich; Downs Lane, Water Lane, Ingham; Highfield Farm, Brooke, Norwich; The Loop, Poringland, Norwich; Ash Tree Farm, Alburgh, Harleston (Dec. 11); Southcote, Bulmer Road, Winterton-on-Sea, Great Yarmouth; Aldous Yard, Harleston; Teaseland Green, Elsing, Dereham; Downing Farm, Winterton-on-Sea, Great Yarmouth; Mill Street, Buxton, Norwich; Mundham House, Mundham, Loddon, Norwich; The Heath, Horsford, Norwich; Beach House Farm, Yarmouth Road, Caiston-on-Sea, Great Yarmouth; Fersfield Airfield, Kenninghall, Norwich; West Green Farm, Doringland, Norwich (Dec. 12).

Somerset. Lambrook Poultry Farm, West Camel, Yeovil; Rushley Farm, Chilthorn Dormer, Yeovil (Dec. 5); Lower Oackley Farm, Chilthorne, Dormer, Yeovil (Dec. 11); Laburnham Cottage, Gallhampton, Castle Carey (Dec. 12).

Suffolk. The Chestnuts, Menewden, Woodbridge; The Homestead, Woodton, Bungay, Airfield Farm, Topcroft, Bungay (Dec. 6); Spring Lane, Topcroft, Bungay (Dec. 7); Pakenham Lodge, Bury St. Edmunds; Church Road, Woodton, Bungay; Dairy Farm, Topcroft, Bungay; Hill Farm, Flixton, Bungay (Dec. 8); Bents Yark, The Quay, Beccles (Dec. 9); Fennell Farm, Woodton, Bungay; College Cottage, Great Cross, Bungay; Red House Farm, Topcroft, Bungay; Hall Farm, Topcroft, Bungay; The Homestead, Topcroft, Bungay (Dec. 10); 6, The Street, Earsham, Bungay; Cransford, Woodbridge (Dec. 11); The Bungalow, The Grove, Town Street, Brandon (Dec. 12).

Surrey. Gleville Farm, Thorpe Lane, Egham (Dec. 6).

Yorks. 12 Ryegate, Helmsley; 4 Ryegate, Helmsley; 7 Ryegate, Helmsley (Dec. 9); 9 Station Road, Helmsley (Dec. 12).

Swine Fever

Ches. Sheaf Farm, Stapleford, Tarvin (Dec. 9).

Denbigh. Overton Road, Bangor-on-Dee, Wrexham (Dec. 8).

Durham. Cragside Farm, Eastgate, Bishop Auckland; Old Mill Farm, Elwick, West Hartlepool (Dec. 5).

Flints. Bodrhyddan Home Farm, Rhuddlan, Rhyl; Chambers Lane Farm, Mynydd Isa, Mold (Dec. 12).

Hereford. The Mynde, Much Dewchurch (Dec. 5).

Lancs. Piggeries, Waxy Lane, Freckleton, Preston (Dec. 7); Mythop Lodge Farm, Mythop, Blackpool; Smaller Gorse Farm, Cronton (Dec. 8).

Mont. Gaer Mill, Forden, Welshpool (Dec. 6).

Norfolk. Japonica Cottage, Middlesex, Acle, Norwich (Dec. 5); School Farm, Kirby Bedon, Norwich (Dec. 7).

Notts. Holly Farm, Thoroton, Newark (Dec. 2).

Salop. Mossey Green Farm, Dawley, Wellington (Dec. 5).

Somerset. Edbrook Farm, Cannington, Bridgwater (Dec. 8).

Suffolk. Glebe Farm, Badingham, Woodbridge (Dec. 6).

Warwicks. The Hollies, Burton Green, Kenilworth (Dec. 8); Fulwood Field Farm, Earlswood, Solihull (Dec. 9).

Wilts. Manor Farm, Teffont, Salisbury (Dec. 8).

Worcs. 1 Union Lane, Droitwich (Dec. 8).

Yorks. Kirbridge Farm, Stanwick St. John, Aldbrough St. John (Dec. 5); 4 Hornsea Road, Aldbrough, Hull; Layton Lane Farm, Melsonby, Richmond (Dec. 7); Grange Farm, Sigglesthorne, Hull (Dec. 8); Manor Farm, Rudston, Driffield; 454 Hull Road, Dunswell, Beverley; Village Farm, Eppleby, Richmond (Dec. 12).

Letters to the Editor

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

SCIENTIFIC

The (Oedema Disease) Neuro-oedema Toxin of Haemolytic *Escherichia coli*

Sir,—In reviewing the literature on *Shigella dysentariae*, I have been impressed with the similarity between the effects produced by the Shiga neurotoxin in experimental animals and the effects produced by the toxic substances in oedema disease bowel extracts and certain haemolytic *Escherichia coli* extracts when these substances are injected intravenously into experimental pigs. Papers by Anderson *et al.* (1945) and Dubos and Geiger (1946) describe the isolation of the Shiga toxin by precipitation with ammonium sulphate and with trichloracetic and hydrochloric acids. Van Heyningen and Gladstone (1953) extracted the Shiga toxin from washed cultures by heating the organisms for one half-hour at temperatures of 56° to 59° C. (*p*H 6.0) followed by standing at room temperature for 3 hours at *p*H 11.

In preliminary experiments designed to determine the feasibility of the above methods in the study of the toxic substances involved in the aetiology of oedema disease, I have the following to report.

Portions of an extract prepared from the intestinal contents of a pig that had died of oedema disease, and which produced typical oedema disease when injected intravenously in 10 ml. quantities, were treated with 2 per cent. trichloracetic acid or with 30 per cent. ammonium sulphate. When precipitates derived from 10 ml. of the bowel extracts were resuspended in 1 per cent. Na_2HPO_4 solution and injected intravenously into each of the 2 weanling pigs, typical oedema disease was produced.

A haemolytic *E. coli* strain, 0139:K82(B)H1, isolated from the above pig, was seeded to pork infusion agar containing 3 per cent. peptone, 0.5 per cent NaCl, 0.5 per cent. K_2HPO_4 and 0.5 per cent. dextrose, and adjusted to *p*H 7.8—8.0. Following an incubation period of 96 hours at 37° C., the growth was washed off with saline solution and then alternately frozen and thawed 12 times. The supernatant fluid of this suspension, following centrifugation, produced typical oedema disease when injected intravenously in 5 ml. quantities into weanling pigs. Precipitates of this material produced by treating with 2 per cent. trichloracetic acid or 30 per cent. ammonium sulphate and resuspended in 1 per cent. Na_2HPO_4 also produced typical oedema disease when injected intravenously into 3 pigs.

Extracts of 24-hour cultures of the same *E. coli* strain grown on turkey infusion agar, *p*H 7.8—8.0, prepared by the method of van Heyningen and Gladstone (1953), also produced characteristic oedema disease when injected intravenously into 2 pigs. A similar extract prepared from the washed organisms grown for 24 hours on pork infusion agar, killed a weanling pig within 16 hours. In this case oedematous lesions were not observed.

For the benefit of research workers who might attempt to reproduce oedema disease with re-suspended ammonium sulphate precipitates, it should be pointed out that the ammonium sulphate should be removed by dialysis or by other means. Failure to do this will result in death of the injected pigs within a few minutes following inoculation.

These studies indicate that the toxic oedema disease-producing substance elaborated by certain haemolytic *E. coli* serotypes either is a protein or is closely associated with a protein. It may be similar to the Shiga neurotoxin. Obviously, oedema disease should be technically referred to as "*haemolytic* E. coli *toxaemia*."

Yours faithfully,
D. W. GREGORY.

1414 E. Washington St.,
Washington, Iowa,
U.S.A.
November 28th, 1960.

References

ANDERSON, C. G., BROWN, A. M., & MACSWEEN, J. C. (1945). *Brit. J. Exp. Path.* **26.** 197.

DUBOS, RENE J., & GEIGER, JAMES W. (1946). *J. Exp. Med.* **84.** 143.

GREGORY, D. W. (1957). *Vet. Med.* **52.** 252.

VAN HEYNINGEN, W. E., & GLADSTONE, G. P. (1953). *Brit. J. Exp. Path.* **34.** 202.

GENERAL

The Racing Greyhound

Sir,—I would like to support Mr. Bateman's answer to Mr. Holmes's query concerning C.V.H. (*Vet. Rec.* November 12th).

During my 2-year period under him at the kennels, I carried out *post-mortem* examinations on 26 dogs, 17 of which were healthy animals destroyed for economic reasons. None of the carcases showed any macroscopic lesions which I could attribute to C.V.H. I realise, humbly, that my *post-mortem* technique is not all that it should be, and unfortunately, no histological examinations were carried out. There was no illness, slight or severe, that we could diagnose as C.V.H.

It is, however, of interest to note that on a series of blood examinations carried out by the Wellcome Research Laboratories, the following results were obtained:—

Out of 32 blood samples examined, 23 were positive to the cell diffusion test, and 28 were positive to the virus neutralisation test, giving titres of from 1:100 to 1:30,000. Two samples had titres below 1:3. None of these Greyhounds had been vaccinated against C.V.H.

Three of the dogs were "off colour" at the time of sampling, the remainder were healthy animals ranging in age from 16 months to 7 years. The majority of them had been "off colour" at some time during their lives.

The conclusion to be drawn from this is that C.V.H. is of no economic importance amongst Greyhounds passing through, or kept in, these kennels.

Yours faithfully,
M. F. N. ETHERIDGE.

427, Pinner Road,
North Harrow,
Middlesex.
November 29th, 1960.

Pneumo-peritoneum in a Pregnant Guernsey Heifer

Sir,—It was pleasing to read Bradley's account of a bovine animal showing pneumoperitoneum, more especially with regard to his conjecture on the origin of the condition.

However, it might not be out of place to suggest that any bovine animal whose pelvic bones relax is quite likely to suffer other forms of spontaneous tissue degeneration. Unchecked, the condition seems likely to terminate in relaxation of the entire skeleton, with rents in the viscera, fearsome to behold.

Yours faithfully,
G. A. EMBLETON.

42, Brownston Street,
Modbury,
Ivybridge,
Devon.
December 5th, 1960.

The Use of Promazine Hydrochloride in Equine Practice

Sir,—An interesting article under the above heading appeared in THE VETERINARY RECORD of May 9th, 1959, subscribed by Mr. J. A. Cunningham, M.R.C.V.S., of Leighton Buzzard.

An experience I had to-day prompts me to report it in our professional journal as likely to interest colleagues in equine practice.

I attended a racing stable this morning to apply the actual cautery (deep line-firing and blistering) to both forelegs of three high-couraged race-horses, one a 7-year-old and the other two 4-year-olds.

My invariable habit is to cast with hobbles, thoroughly anaesthetise with chloroform, and perform under such complete general anaesthesia.

The trainer of 2 of these animals had begged me not to cast his geldings but to fire them standing under a local anaesthetic. I emphasised that in my view no local anaesthetic would suffice. He was quietly obdurate that he did not want his animals "thrown" and I agreed not to do so. Conceivably, he may have lost an animal with a broken back in that way: I do not know.

This is what happened. To each of his animals I gave an intramuscular injection in the breast of 5 x 2 ml. ampoules (100 mg. per ampoule) of promazine hydrochloride.* I then cast, chloroformed and

* Sparine, John Wyeth & Brother Ltd., Havant, Hants.

line-fired the third horse. He was on his feet and finished with, when I got to the other two about 50 minutes later. I was very much impressed by the efficiency of the tranquilliser. The animals literally "stood for it" in remarkably complacent style as firm as rocks. The only restraint was a twitch on the lip and one of my lads holding up the other foreleg. There were no untoward effects from the injections and a good time was had by one and all almost including the horses.

I shall always prefer to cast and chloroform in such cases, but the sedation produced by the promazine hydrochloride was spectacular.

Yours faithfully,
F. W. CHAMBERLAIN.

22, Ewell Road,
Cheam,
Surrey.
November 22nd, 1960.

B.B.C. Television : Foot-and-Mouth Disease

Sir,—I listened to the programme "Panorama" on Monday, December 5th. From the outcome of the discussion on foot-and-mouth disease I feel the profession fared badly.

Why was no opportunity given by Ludovic Kennedy to mention the various types of foot-and-mouth disease virus, or of the impracticability of multiple vaccination both on the grounds of economy and time?

It is deplorable that no time was given to illustrate the fact that the cost to the nation of an inferior vaccination programme would be many times as expensive as the present policy. It is even more disquieting that no reference was made to the fact that the British farm livestock industry is the finest in the world and we as a profession need to be proud of the part we play in keeping it that way.

Yours faithfully,
E. MICHAEL PITTAWAY.

40 Queens Road,
Coventry,
Warwicks.
December 6th, 1960.

How Not to Write to Colleagues

Sir,—I am prompted by Mr. Graham-Jones's letter to give him another chance to air his seemingly profound knowledge of the art of letter writing.

A letter is basically a method for conveying facts from place to place; and while I must admit that the member who wrote regarding the protruding tapeworm could have phrased his thoughts a little better only a mentally deficient person could have failed to realise what specific information the writer required.

What really astounds me, however, is that Mr. Graham-Jones sets himself up, above all other members, as an authority on the written word. He is, in fact, demanding that all letters he receives shall be correctly headed, correctly ended and that the contents shall be correct in all detail.

Yes, Mr. Graham-Jones, I do think you are oversensitive. I also think you may be hypocritical, unless you informed the member who wrote you, of his bad grammar, before writing to THE VETERINARY RECORD.

I too, write letters to Mr. Graham-Jones. These letters are, I must admit, of mediocre literary standard. I have addressed him as "Dear Sir" because I do not know him personally and because I hold him in some respect (as an authority on exotic pets only). Surely he will forgive me this terrible breach of etiquette so long as I make my points clear.

The member who wrote to Mr. Graham-Jones requesting (not demanding, Sir) information about tapeworm treatment, cannot, I am very sure, have intended his last sentence "as an impertinent demanding insult." To suggest so is to suggest that we are laughing at Mr. Graham-Jones!

In conclusion, I trust that he will forgive my lack of grammar, and in future confine himself to the scientific regions he knows so well.

Yours faithfully,
F. N. BOLTON.

131, Shafto Way,
Newton Aycliffe,
Co. Durham.
December 4th, 1960.

Brucella Infection and Undulant Fever in Man

Sir,—On page 828 of THE VETERINARY RECORD of October 1st, you reviewed Sir Weldon Dalrymple-Champneys' book on undulant fever.

As a victim of the disease, and of 2 years of misdiagnoses, I was particularly interested to read of about 160 different conditions that had been diagnosed in other sufferers from undulant fever.

The list ranges through the whole of the alphabet (bar j.q.w. & z), and includes adreno-medullary tumour, Bornholm disease, chronic constipation, duodenal ulcer, epidemic vestibulitis, farmer's lung, general ill-health, hysteria, infective endometritis, Koch's adenitis, leptospirosis, migraine, neurosis, otitis media, pyloric stenosis, reticulosis, spontaneous hypoglycaemia, thrombo-cytopenic adenitis, urethritis, and vagotonia.

It does not include a broken leg but it does fracture of lumbar vertebra. Nor does pyorrhoea (which cost me a fairly sound set of teeth) appear in the list, but there was one case of dental caries.

One wonders how many other unrecorded conditions have been diagnosed in undulant fever sufferers?

Which all goes to emphasise your point that "... the human population *must** be protected from brucellosis. . ."

Yours faithfully,
J. R. FREAN,
Senior State Veterinarian.

Robertson,
Cape Province.
November 30th, 1960.

* My italics.